International Conference

ABSTRACTS

Frontiers in Science: An Integrative Approach in Solving Global Challenges

10th & 11th September, 2025

Organized by

Krishnagar Government College

in association with

IQAC, Krishnagar Government College

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International Conference

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BOOK OF ABSTRACTS

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Krishnagar, Nadia, West Bengal

India

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Preface

The **International Conference on Frontiers in Science: An Integrative Approach in Solving Global Challenges (ICFS-2025)** will be held on **10th and 11th September 2025** at **Krishnagar Government College, Nadia, West Bengal, India**, in a **hybrid mode** (online and offline). Conceived as a vibrant and intellectually rigorous platform, the conference will bring together academicians, researchers, industry professionals, and students to deliberate on the critical role of interdisciplinary approaches in addressing the grand challenges of the twenty-first century. In an era shaped by rapid environmental, technological, and socio-economic transformations, issues such as climate change, energy security, pandemics, food scarcity, public health, and sustainability call for collaborative solutions that transcend the boundaries of individual disciplines.

The hosting institution, **Krishnagar Government College**, established in 1845, is among the oldest centers of higher education in West Bengal and is widely recognized as a symbol of academic distinction. With a distinguished legacy of nurturing eminent scholars such as geologist **Pramatha Nath Bose** and poet **Dwijendralal Ray**, the college has upheld its reputation for excellence while embracing modern approaches to teaching and research. Organizing ICFS-2025 at this historic institution is particularly significant, as it connects a heritage-rich seat of learning with a global scientific dialogue. Situated in a semi-urban setting and serving students from both rural and urban backgrounds, the college reflects the inclusive vision of higher education. Hosting an international conference of this nature enhances its impact beyond regional boundaries, empowering first-generation learners and young scholars through exposure to frontier research, interdisciplinary collaboration, and international academic networking.

The objectives of ICFS-2025 are threefold. First, to **foster interdisciplinary collaboration** across diverse domains of science—including physical, chemical, biological, environmental, earth, material, mathematical, and computational sciences—so as to develop integrated strategies for solving global problems. Second, to **showcase frontier research** by offering a platform for innovative discoveries, technological advances, and policy-relevant insights that contribute to sustainable development and societal well-being. Third, to **empower young minds**, particularly students from rural and semi-urban regions, through active engagement in research communication and academic exchange. In alignment with the **National Education Policy (NEP) 2020**, the conference emphasizes undergraduate research, dissertation work, and active student participation.

ICFS-2025 at Krishnagar Government College thus stands as a bridge between heritage and innovation, inspiring collective action towards a sustainable and knowledge-driven future.

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Message from the Honorable Director of Public Instruction, Department of Higher Education, GoWB

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Message

It gives me immense pleasure to extend my greetings to all participants of the *International Conference on Frontiers in Science: An Integrative Approach in Solving Global Challenges* (ICFS-2025), organized by the IQAC, Krishnagar Government College, Nadia.

In recent years, global scientific gatherings and collaborations have increasingly embraced interdisciplinary and integrative frameworks, recognizing that solutions to problems often lie at the confluence of varied disciplines. Against this dynamic backdrop, ICFS-2025 stands as a timely and meaningful initiative to catalyze cross-disciplinary dialogue between the various sciences, uniting researchers and scholars from diverse scientific disciplines to explore emergent and innovative methodologies. It is also my fervent hope that the conference shall address complex global challenges of today such as environmental sustainability, public health and technological innovation, and so on.

Krishnagar Government College, being one of the oldest and pioneering institutions in higher education, holds a rich legacy of academic excellence. The Internal Quality Assurance Cell of the college has long been dedicated to the enhancement of institutional quality through actionable planning, stakeholder engagement and monitoring. I sincerely hope that the college reaffirms its commitment to fostering scientific discourse, and positions itself as a regional hub for encouraging interdisciplinary scientific exchange.

Along with my best wishes for the success of the event, I warmly encourage all participants—scientists, educators, researchers and students—to contribute thoughtfully, collaborate actively, and harness this opportunity for collective growth.

M. Manna

Dr. Madhumita Manna, WBSES
Director of Public Instruction,
West Bengal

Message from the Honorable Vice-Chancellor, University of Kalyani

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Estd. 1960

Professor Kallol Paul
Vice-Chancellor

No. V.C./F.10/08/2025/DP-2577 *Aug 26, 2025*

FROM THE VICE-CHANCELLOR'S DESK

It gives me immense pleasure to convey my warm greetings on the occasion of the *International Conference on Frontiers in Science: An Integrative Approach in Solving Global Challenges (ICFS-2025)*, organized by Krishnagar Government College in collaboration with the Internal Quality Assurance Cell (IQAC) on 10th September 2025.

In the present era of rapid scientific and technological advancement, the world is facing unprecedented challenges related to climate change, public health, sustainable development, energy crisis and food security. Addressing these issues requires not only path-breaking research but also a collaborative, integrative approach that transcends disciplinary boundaries and geographical borders. I am delighted that this conference provides such a platform where scholars, researchers and practitioners from diverse domains can come together to exchange ideas, share innovations and deliberate on solutions to global problems.

Academic gatherings of this nature inspire young minds, foster interdisciplinary dialogue and strengthen the culture of research and innovation. They also reaffirm our collective responsibility to contribute to the well-being of humanity through the application of science and knowledge.

I extend my sincere appreciation to the Principal, faculty members, organizing committee, and collaborators for their dedicated efforts in convening this international conference. I am confident that the deliberations and outcomes of ICFS-2025 will open new avenues of knowledge and pave the way for future collaborations in scientific research and societal development.

I wish the conference grand success and the participants a fruitful and enriching experience.

26/8/25

(Professor Kallol Paul)
Vice-Chancellor
Kalyani University

Message from the Honorable Vice-Chancellor, Kanyashree University

Prof Tapati Chakraborti
Vice Chancellor
Kanyashree University
Krishnagar, Nadia

It is a great pleasure to extend my warm greetings and best wishes to the organizers, delegates and participants in ICSF-2025 organized by Krishnagar Govt College in collaboration with IQAC.

The thrust areas of the conference on environmental changes, public health, and energy security would highlight the interconnectedness of these concerns. In the present scenario, the energy security stands at the core of global efforts to transfer towards greener economies and sustainable development.

The severity of climate change and pollution causes behavioural changes, the economic implications of which altogether result in environmental damage. So, environmental dilapidation, public health deterioration, and unsustainable energy consumption are not discrete problems but somewhat entwined aspects of a "triple planetary crisis" that includes climate change, pollution and ecological loss.

Therefore, I acclaim the organizers for their thoughtful initiatives to organize this conference on very current crucial global issues and congratulate all to make the conference of great success.

Tapati Chakraborti
(Tapati Chakraborti) 02/9/2025

Vice-Chancellor
Kanyashree University
Krishnagar, Nadia
West Bengal-741101

Message from the Officer-in-Charge, Krishnagar Government College

Greetings From Krishnagar Government College.

It is a great honor to welcome all distinguished speakers, delegates, researchers, and participants from India and abroad to the *International Conference on "Frontiers in Science: An Integrative Approach in Solving Global Challenges" (ICFS-2025)*, organized by Krishnagar Government College in association with the Internal Quality Assurance Cell (IQAC).

Founded in 1845, Krishnagar Government College holds a distinguished place as one of the earliest institutions of higher education in Bengal. For almost two centuries, it has served as a cradle of learning, nurturing scholars of great repute while remaining dedicated to the pursuit of knowledge. The college continues to uphold this rich legacy through a strong tradition of teaching and research, while at the same time embracing change to meet the evolving challenges of higher education in a global context.

The hosting of ICFS-2025 is an important milestone in this tradition. In today's world, where climate change, sustainability, energy security, and public health are urgent concerns, the relevance of scientific inquiry and interdisciplinary collaboration cannot be overstated. This conference seeks to provide a platform where established experts, early-career researchers, and students come together to exchange ideas, engage in dialogue, and explore innovative solutions to global challenges.

The Abstract Book is a reflection of this shared endeavor. Bringing together contributions from participants across India and abroad, it offers valuable insights into current research and future directions.

I sincerely thank the **Department of Higher Education, Government of West Bengal, for their support** in making this initiative possible. I also wish to place on record my deep appreciation of the **Organizing Committee**, whose dedication and tireless efforts have shaped this conference. Finally, I am grateful to the speakers, contributors, and participants for enriching the event with their presence and scholarship. I hope ICFS-2025 will open new avenues of collaboration and inspire meaningful contributions to the global scientific community.

Dr. Sobhon Niyogi
Officer – in – Charge
&
Associate Professor, Department of Chemistry
Krishnagar Government College
Krishnagar - 741101, West Bengal, India

Message from the Desk of the IQAC Coordinator

It gives me immense pleasure to extend my warm greetings to all the participants, researchers, academicians, and distinguished guests of this International Conference. The theme of this conference resonates deeply with the values of academic excellence, innovation, and global collaboration that the IQAC strives to uphold and promote within our institution.

At the heart of IQAC's mission lies the commitment to continuous improvement in the quality of education and research. Conferences like these serve as dynamic platforms for the exchange of knowledge, critical discourse, and interdisciplinary dialogue—key elements that contribute to the holistic development of our academic ecosystem.

I congratulate the organizing committee for their dedication and meticulous efforts in bringing together such a diverse and enriching body of work, as reflected in this abstract volume. I am confident that the deliberations and insights shared during the conference will inspire new ideas, partnerships, and pathways for impactful research and learning.

Wishing all participants a meaningful and intellectually stimulating experience.

Dr. Kalidas Das
IQAC Coordinator,
&
Associate Professor and Head, Department of Mathematics
Krishnagar Government College
Krishnagar - 741101, West Bengal, India

Message from Convenors

It is our immense pleasure to organize the two-day International Conference entitled "**Frontiers in Science: An integrative Approach in Solving Global Challenges"** on 10th and 11th day of September, 2025. This two-day gathering aspires to bring together distinguished academicians from across scientific disciplines to foster a vibrant exchange of ideas and collaborative knowledge sharing. Our aim is to provide a dynamic platform where both students and researchers can benefit from exposure to diverse methodologies, perspectives, and emerging innovations—each playing a vital role in addressing the global challenges of recent time. We are deeply honored by the commitment of our distinguished keynote speakers and resource persons, whose expertise and insight continue to elevate the academic rigor and inspiration of our event. Our heartfelt congratulations go to all contributors featured in this **Book of Abstracts**, which encompasses over 550 abstracts spanning eight scientific domains. This compilation offers a rich glimpse into the innovative research carried out by our esteemed participants.

We are sincerely grateful to the **Higher Education Department, West Bengal Education Service** for their unwavering support. Our deepest appreciation goes to the **Officer-in-Charge of Krishnagar Government College** for his continued cooperation and guidance, as well as to the **IQAC Coordinator** for his valuable suggestions and inputs.

A special note of thanks to the dedicated members of the Organizing Committee, whose commitment, hard work, and enthusiasm have been instrumental in making this conference a meaningful and impactful academic endeavor.

May this conference not only celebrate scientific inquiry but also serve as a catalyst for meaningful interdisciplinary connections, fostering collaborations that transcend borders and disciplines—much like other landmark conferences that strive to serve as reference points and sparks for future research.

Dr. Pritha Mandal
Dr. Nirmalendu Hui
Dr. Moumita Basu

Conveners
ICFS 2025

Message from the Organizing Secretary & Joint Secretaries

It is our privilege to extend a warm welcome to you to the **International Conference on "Frontiers in Science: An Integrative Approach in Solving Global Challenges" (ICFS-2025)**, organized by *Krishnagar Government College* in association with the IQAC, on **10th–11th September 2025**. Designed as a dynamic forum for intellectual exchange, this conference convenes scientists, researchers, educators, industry professionals, and students to engage with the urgent global challenges of climate change, sustainability, energy security, and public health. By fostering interdisciplinary collaboration across the physical, chemical, biological, environmental, computational, and material sciences, ICFS-2025 aims to stimulate innovative approaches and solutions of lasting relevance.

In conjunction with the event, we are pleased to present the **Abstract Book of ICFS-2025**, which compiles the scholarly contributions of distinguished participants from India and abroad. Each abstract embodies rigorous academic effort and creative inquiry, offering both a glimpse into contemporary research and a window to future directions. We trust that this volume will not only serve as a valuable companion to the conference proceedings but also as a useful reference for researchers and students in the years to come.

We express our sincere gratitude to the Department of Higher Education and the University of Kalyani for their steadfast support and cooperation. We also gratefully acknowledge our patrons, advisory committee members, distinguished speakers, and contributors, whose encouragement and engagement have been invaluable. Special appreciation is extended to the faculty colleagues and volunteers, whose unwavering commitment ensured the seamless execution of the conference and this publication, without whose support the accomplishment of this mission would have been impossible.

It is our earnest hope that ICFS-2025 will inspire meaningful dialogue, nurture collaboration, and contribute towards strengthening a research-driven culture in alignment with the vision of the National Education Policy. We extend our best wishes to all participants for an intellectually stimulating and rewarding experience.

With warm regards,

Dr. Subhadip Nath
Organizing Secretary
ICFS 2025

Dr. Saswati Bhattacharya
Dr. Krishnendu Sarkar
Dr. Gopal Ghosh
Joint Secretaries
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HPP-20:Artificial Neural Network (ANN) Algorithm: A Study

Basir Ahamed Khan

HPP-21:Dominance of the Stapler Mechanism in M1 Bands of $A \approx 80$ Nuclei

Amit Kr. Mondal and Anagha Chakraborty

HPP-22:Elucidation of Structural and Electrical Behaviour in 10 mol% Gd-Doped Calcium Molybdate

Gunjan Das, Abhigyan Dutta

HPP-23:Structural and Electrical Properties of $La_{0.01}Na_{0.99}NbO_3$ Perovskites

Pritha Dey, Abhigyan Dutta

HPP-24:The Role of Total Derivative Terms in Higher Order Theory of Gravity

Dalia Saha

HPP-25:Exploring Chaotic Motion of a Particle in the Centre of a Galaxy with a Prolate Halo

Uditi Nag, Yeasin Ali, Suparna Roychowdhury

HPP-26:A Monte-Carlo Simulation of Response Characteristics of Nano-Composite Gas Sensors

Aditi Sarkar

HPP-27:Octahedral Distortion Induced Phonon Vibration and Electrical Conduction in Double Perovskite A_2SmTaO_6 (A =Ba, Sr, Ca)

Binita Ghosh

HPP-28:Opto-Electronic Visible Light-Based Non-Invasive Blood Glucose Monitoring

Md Iftekar Alam, Moumita Mukherjee

Keynote Address

Keynote Address

Dirac Materials: Past and Present

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ABSTRACT

The physics of two dimensional (2D) materials is always intriguing in their own right. Dirac materials are a class of complex and functional nanomaterials offering great potential in the development of new electronic components. In this talk, we would like to present some theoretical calculations of electronic properties of graphene, S-graphene, phagraphene, and 8-16-4 Graphyne systems. A tight binding (TB) model along with density functional theory (DFT) will be used to unravel the characteristic features of Dirac points in these systems. Further, we will discuss an analytical scheme to address the emergence and robustness of Dirac fermions in phagraphene network. All these theoretical results in non-honeycomb structure may shed light on device fabrication in nano opto-electronic technology and materials characterization techniques in 2d carbon allotropes.

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Invited Talks

Invited Talk - 01

Towards Better Health

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ABSTRACT

Prevention of diseases and healthcare directly contributes to a nation's public health. A key prerequisite is, of course, investments in medical research that promote healthy aging. There is also widespread recognition that the current global systems for innovation and access to medicines need reform. While it is safe to say that more people will likely live longer, healthier lives in the future, it is also probable that future generations will face health threats that are less common or even unknown today. The development landscape is becoming increasingly complex and crowded in a world where health threats mainly originate outside the healthcare sector. Ultimately, it is very reasonable to expect that the use of medicines will be significantly influenced by research and technology development, consumer education, and increased self-awareness about lifestyle and diseases. Three main areas of medical research are essential: clinical and epidemiological research, as well as understanding how environment and lifestyle impact healthcare system effectiveness. By combining and analyzing information from our genome with other clinical and diagnostic data, patterns can be identified that help determine our risk of developing disease, detect illnesses earlier, and select the most effective interventions to improve our health—whether these involve medicines, lifestyle changes, or simple dietary adjustments. I will highlight the latest developments in medical research that influence current medical practices and the healthcare system, along with their relevant implications for human health.

Invited Talk - 02

Targeting Safe Aquifers for Rural Water Supply in Bangladesh: Driller-Led and Digital Interventions for Upscaling in South Asia

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ABSTRACT

Geogenic arsenic (As) in groundwater exposes millions to severe health risks, with about 46 million people in Bangladesh still consuming water above the WHO drinking-water guideline of 10 µg/L and around 28 million above the national standard of 50 µg/L. Identifying hotspots and tracking real-time exposure at the point of supply are essential for ensuring equitable access to safe water. Millions of wells are installed by local drillers, who act as the main drivers for the provision of drinking water, especially in rural settings. Our approach combines standardized training for local drillers to recognize low-arsenic stratigraphic windows using sediment color with ASMITAS, a digital platform that guides well siting and documents lithologs and water-quality results based on sediment color. This mode of field data capture is a valuable tool for aggregating baseline information on site-specific hydrogeological attributes and potential risks at the village scale, following the Arsenic Safe Union (ASU) concept, particularly in Bangladesh. ASU reframes decision-making from individual wells to community exposure, integrating societal values with hydrogeological conditions to prioritize interventions, and offers a workflow designed for scale across Bangladesh, with potential applicability in the Indo-Gangetic Plain of India.

Long-term monitoring of drinking-water sources shows variations in arsenic concentration within a narrow, seasonally modulated band, enabling the development of rules for targeting safe aquifer depths for water supply. During the intervention of the Sustainable Arsenic Mitigation (SASMIT) project in Bangladesh, using a driller-led approach, shallow, manually drilled wells in relatively oxidized or less-reduced red and off-white sands were found to yield arsenic-safe water, particularly in southern areas of Bangladesh. Intermediate and deep aquifers remain consistently safe and are hydraulically separated from contaminated shallow units by intervening aquitards, as reflected in groundwater-level patterns. Combining driller-led stratigraphic logging with ASMITAS increases the safe-well hit rate. A complementary IoT layer can stream groundwater-level and quality indicators through an interactive digital dashboard to support maintenance and adaptive management. This integrated approach strengthens driller capacity, improves targeting accuracy, and provides evidence-based, village-scale planning tools for arsenic risk reduction, laying the foundation for national rural water supply programs in South Asia.

Keywords: Sustainable arsenic mitigation; groundwater quality; sediment color tool; ASMITAS; Arsenic Safe Union (ASU); driller capacity building; IoT monitoring; safe aquifer targeting; rural water supply; Bangladesh; South Asia.

Invited Talk - 03

Effect of Nano Clay on Morphology of Incompatible Polymer Blends

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ABSTRACT

The effect of organoclay platelets on morphologies of three blend compositions (80/20, 20/80, and 99.5/0.5 w/w) of nylon-6 (N6) and poly(ethylene-*ran*-propylene) rubber (EPR) has been studied by scanning and transmission electron micrographs. For the 80/20 (w/w) N6/ERP blend, the dispersed domain size (*D*) of EPR phase in the N6 matrix decreased significantly even if a small amount of the organoclay was added. The extent of the decrease in *D* in this blend was similar to N6/EPR blend with an in-situ reactive compatibilizer of EPR-*g*-maleic anhydride. The *D* of the blend with the clay did not change upon further annealing at high temperatures, which suggests that the clay seems to be an effective compatibilizer. But, for the 20/80 (w/w) N6/EPR blend, dispersed N6 domain did not decrease with increasing the amount of the clay up to 2 wt %. Moreover, the dispersed N6 domains were not stable against further annealing at high temperatures; thus, coalescence of N6 domains was observed. Furthermore, for 99.5/0.5 (w/w) N6/EPR blend dispersed EPR domains did not change with the amount of the clay. The results indicate that as long as the clay becomes exfoliated in the matrix, the exfoliated clay plates effectively prevent the coalescence of the dispersed domains.

Invited Talk - 04

Indian Space Program: Challenges Ahead

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ABSTRACT

Indian Space Research Organization (ISRO) is a beacon of scientific ambition, innovation and national pride. It is a one of India's most inspiring institutions. Since its foundation in 1969, ISRO has transformed India's space capabilities from humble beginning into a globally recognized leader in space exploration and satellite technology. Communication satellites, weather monitoring and navigation satellites take vital role in tele-communication, agriculture, disaster management and national security. Through landmark mission like Chandrayaan series, Mars Orbiter Mission, Aditya-L1 and SPADEX, India has been cemented its status among the selected group of space firing nation.

As India continues to rise as a global space power, ISRO faces unique set of challenges like Technological advancements, funding constraints, infrastructure expansion, skilled manpower, international competition, commercialization and private sector involvement, sustainability and space debris & geopolitical and security challenges. From technological innovation and infrastructure expansion and navigation international competition, the road ahead is both daunting and exciting. ISRO's future goals- such as human spaceflight under Gaganyaan mission, space station development, man landing on moon and deep space exploration- require cutting –edge technologies that India is still in the process of developing. These include advanced life support systems, reusable launch vehicles, heavy lift rocket, autonomous rendezvous and docking & deep space communication networks. Addressing these issues through innovation and collaboration will be key to sustaining India's leadership in space exploration.

ISRO's future challenging missions include Gaganyaan, India's first human spaceflight, requiring human-rated rockets and advance life support; Chandrayaan-4, a planned lunar sample return mission involving autonomous docking and re-entry technology; Shukrayaan-1 to study Venus's hostile atmosphere; Mangalyaan-2 for advanced Mars exploration; and the Bhatatiya Antariksha Station (BAS) targeted by 2035, demanding long-duration orbital habitation systems. Each mission pushes technological limits in Sensors, propulsion, navigation, communication and sustainability, shaping India's next leap in space exploration.

Invited Talk - 05

Regular inclusion of simple C*-algebras

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ABSTRACT

We explore Watatani's index theory in the setting of inclusions of simple unital C*-algebras. Focusing on finite-index inclusions, we provide a characterization of regular inclusion- those in which the larger algebra is generated by the smaller algebra and its normalizers. This framework not only deepens our understanding of the structural aspects of such inclusions but also highlights the interplay between index theory and the internal symmetry of C*-algebras.

Invited Talk - 06

Development of Nanomaterials for Targeting Signalling Proteins for Therapeutic Management of Diabetes: A Molecular Docking Predicted Experimental Approach

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ABSTRACT

Nanomaterials have become an essential area for active research for therapeutic management of myriads of diseases including diabetes. In our laboratory the development of poly-lactide-co-glycolide (PLGA) encapsulated nanomaterials was found to have target specific drug delivery and faster action, reduced drug dose leading to least possibility of being cytotoxic when administered in experimental cell line and mice model for therapeutic management of diabetes. The molecular docking study provided ample evidences of good dock score revealing the ability of the core compound encapsulated inside PLGA to effectively bind to different target proteins and modulate their expression. The compounds after being released from its biodegradable polymeric capsule actively undergo protein-ligand interaction which aids in overall glucose homeostasis. Their nanotized size, negative zeta potential, smooth surface, uniform FFT values, biocompatibility, suspended release happens to be the main physico- chemical components of the nanomaterials that suffice such advantage to them. Thus, over the ages with the advent of nanoscience of nanotechnology the nanomaterials have proved to be a refined tool to elicit an array of signalling proteins and associated factors for optimum glycaemic balance which either halts the ignition or delays the progression of the disease thereby rendering a better and longer life to the pre-diabetics and diabetics.

Keywords: Nanomaterials, PLGA, Diabetes, Signalling factors

Invited Talk - 07

Rice's Secret Weapon: How Lectins Fight Climate Change

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ABSTRACT

With climate change intensifying, osmotic stress from drought and salinity poses a significant threat to global food security, particularly for a water-intensive staple like rice. While traditionally known for their role in insect resistance, lectins (a class of carbohydrate-binding proteins) are increasingly recognized for their function in abiotic stress tolerance. We explore this role by characterizing two lectin proteins, Osr40C1 and Osr40g3. In an earlier study, the drought-responsive lectin Osr40C1 was found to be highly accumulated in drought-tolerant transgenic rice plants. To understand its function, we developed transgenic rice lines overexpressing the *Osr40C1* gene. These plants exhibited enhanced drought tolerance compared to wild-type plants. Our findings further reveal that Osr40C1 interacts with chromatin-associated proteins, including OsMNB1B, OsSAM2, OsH4, and OsSAP8, to regulate downstream drought signaling pathways. In a separate investigation, we characterized Osr40g3, another lectin from the OsR40 family. In response to salt stress, Osr40g3 negatively regulates the OsGF14e protein, leading to lower gibberellic acid (GA) accumulation. This, in turn, activates the expansin protein OsEG45, which confers salt tolerance. Additionally, Osr40g3 directly interacts with OsEG45 to positively regulate salt tolerance. Together, these studies demonstrate two distinct strategies by which lectins mediate osmotic stress tolerance in rice. By leveraging these mechanisms, we can develop climate-resilient rice varieties that will be essential for ensuring future food security

Invited Talk - 08

Hypervalent Iodine Chemistry: A New Synthetic Tool for Synthesis of Therapeutic Interested Sustainable Heterocycle

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ABSTRACT

Hypervalent iodine (HVI) reagents have gained prominence as sustainable and versatile tools in modern organic synthesis, offering low toxicity, high reactivity, and unique umpolung capabilities. In our laboratory, we focus on the development of novel HVI reagents with tailored structural features, guided by detailed spectroscopic and crystallographic studies. These new entities not only expand the chemical space of iodine (III) and iodine(V) species but also unlock previously unexplored reactivity patterns.

We exploit the electrophilic nature of HVI reagents for efficient group-transfer reactions, enabling direct introduction of functional groups through umpolung strategies. Furthermore, the relatively weak iodine–ligand bonds in these reagents are strategically utilized for constructing diverse heterocycles under mild conditions, delivering scaffolds with significant biological relevance.

A major thrust of our work involves incorporating carbon dioxide-sourced from ambient air, balloon delivery, or solid surrogates-into organic frameworks. This approach provides a green and atom-economical route to valuable CO_2-derived heterocycles, marrying the principles of sustainable synthesis with cutting-edge reagent design.

Through this integrated approach, spanning reagent innovation, structural chemistry, and application-driven synthesis, our research underscores the vast potential of hypervalent iodine chemistry in addressing both synthetic challenges and sustainability goals in modern chemical science.

Keywords: Hypervalent Iodine; Umpolung Reactivity; Heterocycle Synthesis; Carbon-dioxide utilization.

Invited Talk - 09

Applications of Nanofluids Towards the Emerging Area of Science and Engineering

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ABSTRACT

Nanofluids are colloidal suspensions of nanoparticles (diameters between than 1–50 nm) in conventional base fluids - have created immense attention in past decades due to their elevated thermophysical, and rheological properties. In addition of metallic, non-metallic, or hybrid nanoparticles into traditional fluids like water, oils, or glycols, nanofluids promotes superior thermal conductivity, heat transfer characteristics, and long-term stability. These unique features have enabled their integration across the diversified domain of science and engineering. In renewable energy systems, nanofluids are engaged in solar thermal collectors, photovoltaic cells, and geothermal applications to maximize energy harvesting efficiency. Moreover, electronics cooling benefits from nanofluid-based thermal management solutions, ensuring reliability of compact, high-performance devices. In biomedical engineering, nanofluids facilitate targeted drug delivery, magnetic resonance imaging (MRI) contrast enhancement, and cancer hyperthermia treatments. The manufacturing and automotive sectors utilize nanofluids in machining, lubrication, and cooling systems to improve process efficiency and component lifespan. Moreover, environmental applications such as groundwater filtration, pollutant adsorption, and CO_2 capture leverage functionalized nanofluids for sustainable solutions. Despite these advances, challenges remain in nanoparticle stability, scalability, and environmental safety, necessitating further interdisciplinary research. Overall, nanofluids represent a versatile and enabling technology, with expanding applications shaping the future of high-efficiency, sustainable engineering systems.

Keywords: Nanofluid; Heat Transfer; Mass Transfer; Applications towards real life

Biological Sciences

Regulatory Mechanism Study and Crosstalk Between miR-21 And Its Target Proteins in Human Breast Cancer

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ABSTRACT

MicroRNA-21 (miR-21) plays an important role in the development of breast cancer, although its regulatory nature and the specifics of interactions with target proteins have not been fully elucidated. This study aims to explain key genes and protein interactors of miR-21 related to human breast cancer using bioinformatic analysis. Target genes were chosen based on binding affinity, which facilitates miRNA-mRNA duplex formation. The Argonaute (AGO) protein was examined to evaluate miRNA-mediated silencing. The main miR-21 interacting proteins and genes were identified using existing public databases, STRING, and GeneMANIA. Enrichment and functional annotation were performed with DAVID, PANTHER, UniProt, FunRich, miRwalk, and KEGG. The 3D model structures of miR-21-mRNA duplexes were created and docked with the AGO protein. The results indicate some of the key miR-21 targets in breast cancer pathways, such as FASLG, PTEN, STAT3, NFkB1, TGFB1, EGFR, and HIF1alpha. Molecular docking showed significant interactions between the miR-21-mRNA duplex and the AGO protein. In summary, this research explains the regulatory functions of miR-21 in breast cancer and predicts targetable genes that could influence its prognosis and management. Moreover, the findings contribute to understanding miR-21 actions in gene silencing and identify promising targets for therapy against breast cancer.

Keywords: AGO protein; Breast cancer; Gene enrichment; miR-21.

Microbial Assessment in Industrially Polluted Soils and Their Impact on Heavy Metal Degradation From IDA, Jeedimetla, Hyderabad, Telangana

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ABSTRACT

Identification and analysis of microbial consortia in polluted soils can be used as an indicator of various pollutants impact on dumped landfills and the diversity of microbial community. The aim was an inclusive assessment of the soil microbiological and toxicological hazards of various industrial landfill. Soil microorganisms, crucial for soil functions/functioning, are impacted by heavy metal pollution, affecting essential functions such as nutrient cycling, organic matter cycling, and carbon sequestration. Various microbial properties (including enzymatic activity, microbial community diversity, microbial biomass), reflecting heavy metal effects, show diverse microbial responses influenced by both heavy metal pollution and soil properties. Although extensive research has been conducted in this field, further studies are needed to better understand the intricate relationship between heavy metal (HM) pollution, soil microbial responses, and soil properties influence. Biomonitoring is the process to impart physiological, biochemical, molecular, and genetic changes in an organism toward the level of pollutants. It helps in measurement of contaminants or pollutants that threaten the quality of environment. This work examines the complex interaction between heavy metals and soil microorganisms, focusing on five common heavy metals (HM) (chromium -Cr-, copper -Cu-, nickel -Ni-, lead -Pb-, and zinc -Zn-) in polluted areas. Understanding these details is essential for developing effective strategies to mitigate the adverse effects of HM pollution on soil ecosystems.

Keywords: Soil microorganisms; heavy metal pollution; industrial landfill; strategies to mitigate.

Assessment of Potassium Levels in Lentil (*Lens Culinaris Medik.*) Varieties: A Nutritive Based Approach for Diabetic Patients

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ABSTRACT

Lentils (Lens culinaris Medik.) are an important dietary source of nutrients, or their high protein content and also provide significant amounts of complex carbohydrates, dietary fibre, and various essential minerals including potassium (K). Although potassium is essential for many physiological processes, but becomes a significant health risk for diabetic patients suffering from kidney diseases, where potassium regulation becomes impaired. In this study, different lentil cultivars were analysed to estimate their total potassium content, aiming to identify low-potassium variants suitable for vulnerable populations. The samples were digested using a wet acid digestion method and analysed using flame photometry, a sensitive and reliable technique for potassium quantification. The results revealed significant variation in potassium concentration among the tested cultivars suggests that genotypic differences play a key role in potassium accumulation in lentil seeds. Identifying cultivars with comparatively lower potassium content provides a dietary advantage for individuals who require potassium-restricted diets. This study emphasizes the importance of screening legume crops not only for their nutritional richness but also for their suitability to specific health conditions. The findings contribute to the development of dietary guidelines and the promotion of lentil varieties with improved nutritional suitability for chronic kidney disease and diabetic patients. The findings subsidize to a nutritive-based strategy, aligning with Sustainable Developmental Goal 3– Good Health and Well-being.

Keywords: Lentil cultivars; Potassium estimation; Flame photometry; Diabetic nephropathy.

Development of Phyto-Synthesized Metal Nanoparticles as Sustainable Tool for Next-Gen Biopesticides

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ABSTRACT

Modernization of agriculture enhanced productivity, but consequently attracted numerous devastating pests, thereby threatening food security and post-harvest sustainability as well as causing a significant economic damage to the farmers. Despite ongoing efforts, residual toxicity and bioaccumulation of conventional pesticides remained a problem due to environmental degradation and health issues of the consumers. Metal nanoparticles offer superior efficacy at lower doses with prolonged stability and reduced resistance but their traditional synthesis relies on costly and toxic inputs and hazardous by-products. This study emphases on green synthesis of metal nanoparticles through a low-energy, one-step method using phyto-compounds ensuring low cost, eco-friendliness and biocompatibility. In this study, plant extract mediated green synthesized metal nanoparticles were characterized and tested for their efficacy against stored product pests. The data display very promising results suggesting an effective, cleaner, resource-efficient solution to the conventional agrochemicals and promising candidates for next-generation biopesticides. This approach contributes to United-Nation's Sustainable Development Goals – particularly SDG-12 (Responsible Consumption and Production) by reducing harmful chemical inputs. This material using green technology holds promise for commercial agro-industrial formulation as a sustainable pest management solution.

Keywords: Nanoparticle; Green synthesis; Post-harvest Protection; Sustainable Agriculture

The Impact of Rhizosphere Microbial Community in Withstanding Abiotic Stress

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ABSTRACT

Agricultural crops have to withstand a number of abiotic stresses that cause negative influence on the growth and development of plants, leading to decreased crop yield. These stresses cause nutrient imbalances, a rise in temperatures, soil salinization, and aridity. New agronomic tools will be needed to maintain crop yield and productivity under stressful conditions. One such strategy is the use of microorganisms that are capable of reducing the levels of stress exposed to the plants. Although there have been some studies to explore how some specific microbes act to enhance plant growth, our understanding of how the root microbiome works to shape plant stress tolerance remains unclear. In this study, we mainly focus on three major abiotic stresses in the agricultural field: drought, phosphate, and salt stress, and how the root microbiome helps to increase plant health and how it can be used in agriculture to minimise the impacts of abiotic stress.

Keywords: Abiotic Stress; Beneficial microbes; Microbiome; Plant Growth.

Abiotic Stress Tolerance in Plants: Advancing Transgenic Innovations and Exploring Emerging Frontiers for Stress Resilience

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ABSTRACT

Abiotic stresses such as drought, salinity, heat, and cold climatic conditions pose major threats to global agricultural productivity. Conventional breeding techniques, though valuable, have limitations in addressing complex and multigenic stress traits. Transgenic approaches have provided early breakthroughs by introducing specific genes encoding osmoprotectants, antioxidant enzymes, ion transporters, and stress-responsive transcription factors alongwith stabilization of protein and cellular membrane structures thereby enhancing tolerance in several model and crop plants. Recent advancements in genome-editing technologies, particularly CRISPR/Cas9, TALENs, and ZFNs have revolutionized plant biotechnology by enabling precise, targeted modifications without introducing foreign DNA. An important example is the production of GMOs (Genetically Modified Organisms) by those methods that are resistant to certain abiotic stresses. Various transgenic methods have been used to enhance stress tolerance in various plant species such as rice, wheat, maize and tomato. These tools allow editing native stress-responsive genes or regulatory elements, thus mimicking naturally occurring beneficial mutations. Integration with omics-based platforms (genomics, transcriptomics, proteomics) and synthetic biology has enabled the development of multi-trait, highly adaptable plant varieties with minimal trade-offs. Field validation and long-term environmental assessments of genome-edited plants remain scarce. There is also understanding of gene regulatory networks and epigenetic factors.

This review aims to critically examine the evolution of genetic approaches in enhancing abiotic stress tolerance, spotlight key innovations shaping the next generation of crop resilience, and highlight the gaps that must be addressed to ensure their sustainable deployment. Bridging molecular insights with field-level applications brings various beneficial progresses and future perspectives in agricultural fields.

Keywords: Abiotic stress tolerance; Drought resistance; Gene modification; Genetically Modified Organisms (GMOs); Salinity tolerance; Transgenic Methods.

Glorious *Butea monosperma* and new vistas of its variation research

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ABSTRACT

Purulia, an epitome of *Butea monosperma* is a cradle to four colours of flowers – scarlet, orange, yellow and white that are nurtured in wild since long. During full bloom, its true identity as 'flame of forest' is exhibited which nowadays insanely attracts tourists from all walks of life, ecological enthusiast, nature lovers to Purulia across state and country borders thus disrupting ecological harmony in every sense. Orange, yellow and white colour flower bearing trees are very rare hence, demand immediate conservation. The present study is focused to access variability in such flowers considering six macroscopic and microscopic traits of this tree that has immense socio-economic and cultural importance among the natives. Very interesting and remarkable incidental observations related to contiguous release of petal pigments (dyes) from each treatment in aqueous extraction at room temperature is vastly unexplored. Suitable hypotheses driven explanations have been made that needs in-depth validation through cumulative effort in research and analysis from taxonomists, geneticists, bio-chemists, molecular biologists as well as pathway engineers, horticulturists, plant tissue culturists, palynologists and plant breeders.

Keywords: Aqueous extraction; *Butea monosperma* flower colours; pigments; pollen.

Seedling Phenology: a Key for Understanding the Gorwth and 'Adulthood' of an Annual Plant

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ABSTRACT

Seedlings are the young plant or plantlets produced from the seeds through germination, but not from the other propagules produced naturally or artificially. The seed germination of all plants may be categorized into two groups on the basis of the relative position of the cotyledons with the soil surface. When the cotyledons are raised above the soil surface, it is epigeal. Most of the phanerocotylar seedlings are epigial. On the other-hand when the cotyledons remain in the soil, it is hypogeal as in cryptocotylar seedlings. The commencement of the seedling phase of a plant is marked by the emergence of plumule. A typical dicotyledonous seedling comprises the root, a hypocotyl, a pair of cotyledonary leaves and a plumular bud with subsequent internodes and eophylls. Apart from its size, the seedling of a species differs from its adult individual in several respects. The seedling phase lasts until the young plant assumes the miniature form of the adult individual. Phenological patterns of seedlings are governed by the genetic factors and are species specific; sometimes this pattern varies amongst the individuals. The most important factor for sustenance of seedling in a constantly changing environment and maintenance of the population growth is the successful establishment of seedlings. Studies of phenological patterns of seedling are therefore highly significant in understanding the reproductive ecology of sexually reproducing species.

Keywords: Seedling Phenology; Epigeal; Phanerocotyl; Eophyll.

Climate Change Related Child Crisis and Sustainable -Mitigation

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ABSTRACT

The climate is changing worldwide and affecting the overall health and well-being of children in various ways. India's average temperature has risen 0.7 degree during 1901-2018 which change has affected India in terms of fatalities and economic losses. UNICEF's 2021 report, titled 'The Climate Crisis Is a Child Rights Crisis: Introducing the Children's Climate Risk Index', presents the first child-focused global climate risk index. In India the, extreme weather conditions have led to 17 out of 20 people being vulnerable to extreme hydrological and meteorological disasters. WHO predicts that besides pollution related fatality an additional 250,000 climate-related deaths will occur globally – per year – between 2030 and 2050. In comparison to adult, the children are more vulnerable to the direct and indirect effects of extreme heat, drought, natural disasters. In developing countries children already face the other health and welfare related threats which make them less resilient to confront the additional threat which is caused by climate change. The future of the country depends upon the present children. So, the country should ensure the well-being and protection of every child. So, the global cooperation is needed to mitigate climate change impacts in a sustainable way. This review provides the climate change related health and wellbeing of children and its sustainable mitigation.

Keywords: Climate change; Children; Health and Well-being; Sustainable mitigation.

Phytochemical Studies on Tribally used Aquatic Medicinal Plants of Lalbagh Block of Murshidabad District, West Bengal

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ABSTRACT

Since ancient times, plants have been utilized to treat a wide range of ailments. Conventional medical practices, such as Homeopathy, Ayurveda, and Unani, utilize the understanding of ethnomedicinal plants to address human health problems. Among tribal communities, these plants continue to be used for various traditional healthcare practices. Plants possess a multitude of bioactive chemicals that serve as the foundation for medical care; known as Secondary metabolites. The present study deals with the phytochemical screening and ethnomedicinal documentation of aquatic plants used by the tribal people of Lalbagh block of Murshidabad district. Fourteen aquatic and semi-aquatic plant species belonging to different families have been documented through field surveys and interviews, highlighting their medical importance. Each species then subjected to phytochemical screening using aqueous and organic solvent extracts to detect the different secondary metabolites. Results confirmed the presence of alkaloids, flavonoids, tannins, saponins, terpenoids, phenol etc. These secondary metabolites are associated with specific pharmacological activities that validate the indigenous therapeutic claims. This study aims towards detailed documentation of tribally used ethnomedicinally important aquatic plants with their potential reservoirs of bioactive compounds for future drug development and sustainable healthcare approaches.

Keywords: Phytochemical Screening; Secondary Metabolites; Tribal Ethnomedicinal Profiles; Murshidabad.

Unravelling Pathways linked to Naphthoquinone Production in Elicited *Lawsonia inermis* L.: A *de novo* Transcriptomic Study

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ABSTRACT

Lawsonia inermis L., a plant, useful, both medicinally and commercially, for its vast repertoire of phytochemicals, especially lawsone. This importance, creates a huge demand pressure, which can't be met by traditional farming, which reports low propagation rates. So, micropropagation remains the only tool, for large scale propagation, in regenerating plants, with higher secondary metabolites. In this novel work, three-month-old *in vitro* plants, were elicited, targeting some important phytochemicals, especially lawsone. Salicylic acid treatment showed a higher phenol, lawsone and flavonoid content, as compared to elicitation by yeast extract, chitosan and methyljasmonate. Pair end *de novo* transcriptome analysis was performed. Trinity assembled the reads into 2320 unigenes. The transcript IDs were processed, and annotated. The filtered unigenes were assigned to 142 KEGG modules, with salicylic acid treated plants showing 416 upregulated and 389 downregulated unigenes, compared to control. Five enzymes, like, phenylalanine ammonia-lyase, 4-coumarate-CoA ligase, shikimate O-hydroxycinnamoyltransferase, cinnamyl-alcohol dehydrogenase, 4-hydroxybenzoate polyprenyltransferase, were elicited in salicylic acid treated set, which belonged to phenylpropanoid, flavonoid, ubiquinone and other terpenoid biosynthesis pathways, related to naphthoquinone production in plant. This study, for the first time, not only elicits the phytochemical pool of the plant, but also gives insight into the network of genes and enzymes related to the higher accumulation of lawsone and other important phytochemicals, augmenting the medicinal importance of the plant.

Keywords: Elicitation; Lawsone; *Lawsonia inermis*; Transcriptome.

Effect of Selected PGRs on Augmented Productivity of a High Value Critically Endangered Medicinal Plant Safed Musli

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ABSTRACT

Safed musli (*Chlorophytum borivilianum* Sant. *et* Fernand.), belonging to family Asparagaceae, is a critically endangered medicinal herb. As its major bioactive compounds saponins and some alkaloids are biosynthesized in underground tubers enhanced tuber productivity is a challenge for this medicinal crop. Keeping this in mind, an experiment was designed to augment its tuber yield by using two selected plant growth retardants *viz.,* alar and paclobutrazol.

Foliar application of alar (250 and 500 µg ml^{-1}) and paclobutrazol (75 and 150 µg ml^{-1}) each on 20 days old plants improved over all plant potential of safed musli, measured in terms of some reliable physiological and biochemical parameters along with some selective yield attributes which cumulatively resulted in enhanced productivity of tubers. Data also showed that both the retardants significantly enhanced total saponin content of the tubers. It was also evident from our HPLC data that both the treated chemicals increased the stigmasterol content of safed musli tuber over control.

A conclusion can be drawn from this experiment that the chemical manipulation strategy on enhancement of plant potential and tuber productivity by using the two selected plant growth retardants seem to be a promising technique for effective modulation of tuber yield and consequently of the bioactive compounds.

Keywords: Safed musli; Alar; Paclobutrazol; Stigmasterol.

Comparative Efficacy of Usnic Acid and its Cerium Oxide Nanoparticle Conjugate Against Lung Cancer: An integrated *In-Silico* and *In-Vitro* Study

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ABSTRACT

Lung cancer remains one of the foremost causes of cancer-related deaths globally, necessitating the development of safer and more effective therapies. Usnic acid, a lichen-derived secondary metabolite, exhibits promising anticancer potential but is limited by poor bioavailability and hepatotoxicity. This study explores the therapeutic efficacy of usnic acid-doped cerium oxide nanoparticles (UA-CeO_2NPs) as a targeted nanomedicine for lung cancer treatment.

UA-CeO_2NPs were synthesized and characterized by SEM and FTIR, confirming successful conjugation and nanoscale morphology. In-silico assessments, including molecular docking, ADME profiling, and QSAR-based toxicity prediction, demonstrated that usnic acid is drug-like and binds strongly to lung cancer-associated targets such as POLD1, EGFR, and AKT1. Antioxidant assays (DPPH, ABTS, H_2O_2, FRAP) revealed superior free radical scavenging and DNA protection by UA-CeO_2NPs compared to free usnic acid.

Cytotoxicity assays on A549 lung cancer cells showed enhanced, selective cytotoxicity of UA-CeO_2NPs over free usnic acid and 5-fluorouracil, with minimal impact on normal WRL-68 cells. Functional analyses (GO and KEGG) supported the role of target proteins in DNA repair, apoptosis, and signal transduction.

The improved efficacy of UA-CeO_2NPs stems from the synergistic redox-modulating properties of both components and their ability to enhance cellular retention and release. This nanoconjugate highlights a promising avenue in lung cancer therapeutics by integrating natural compounds with nanotechnology.

Keywords: Lung Cancer; Usnic acid; UA-CeO_2NPs; Nanotechnology.

Phytosolution: Leveraging Plant Biology for Global Challenges and Crisis Mitigation

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ABSTRACT

The escalating global environmental crises, which includes climate change, pollution, food insecurity, and resource depletion, and the demand for innovative and sustainable solutions are ever increasing. Phytosolution, the strategic application of plant biology and biotechnology to address these challenges, has emerged as a promising paradigm for environmental restoration and crisis mitigation. This review examines the multifaceted applications of plant-based technologies in addressing contemporary global challenges, dealing with phytoremediation for environmental cleanup, biotechnological approaches for climate-resilient agriculture, and plant-based solutions for sustainable resource management. Recent advances in plant biotechnology, including genetic engineering, genome editing, and synthetic biology, have expanded the potential of phytosolutions beyond traditional applications. This comprehensive study will aid current research on phytoremediation technologies for heavy metal and organic pollutant removal, biotechnological innovations for developing climate-resilient crops, and plant-based approaches for carbon sequestration and ecosystem restoration. The integration of advanced molecular techniques with traditional plant science has enabled the development of enhanced phytoremediation systems, drought tolerant crops, and bio-based manufacturing platforms. However, challenges remain in scaling these technologies, addressing regulatory frameworks, and ensuring equitable access to biotechnological innovations. This review highlights the transformative potential of phytosolutions in creating sustainable, nature-based approaches to global environmental and agricultural challenges while identifying key research priorities and implementation strategies for maximizing their impact on global crisis mitigation.

Keywords: Phytoremediation; Plant Based Technologies; Sustainability; Global Crisis.

Unlocking Microscopic Evidence: The Expanding Horizons of Forensic Palynology

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ABSTRACT

Forensic palynology is the application of pollen, spores, and other palynomorphs in criminal investigations—offers a compelling intersection between botanical microanalysis and law enforcement. As a subdiscipline of palynology, it harnesses the exceptional resilience and specificity of these particles, which are preserved by sporopollenin & exhibit species and region-specific morphologies known as "pollen fingerprints." With an estimated 1.5 to 2 million pollen-producing plant species worldwide, each possessing unique traits, palynomorphs serve as ecological signatures capable of linking suspects, objects, and crime scenes to distinct environments. Their microscopic size, vast abundance, resistance to degradation, and complex dispersal mechanisms contribute to their evidentiary reliability. Over five decades of research and practice have demonstrated the utility of forensic palynology in reconstructing events, verifying alibis, and enhancing geographic profiling—especially in cases where conventional evidence is absent or compromised. With time, high-profile applications and multidisciplinary collaborations grow, this modern field is being increasingly integrated with geospatial mapping, molecular techniques, and ecological modeling. This present work synthesizes the current methodologies, case-based insights, and future trajectories, establishing forensic palynology as a robust tool for investigative science and a gateway to merging biological expertise with judicial precision.

Keywords: Forensic palynology; palynomorphs; investigative science; judicial precision.

Effect of Light Intensity on Germination and Early Growth of Methi (Fenugreek)

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ABSTRACT

Traditional as well as modern controlled agriculture farming is highly dependable on the understanding of the interaction between environmental factors and plant development. This present work tries to investigate the impact of various light intensities on the initial growth & the germination of *Trigonella foenum-graecum* (methi), a leguminous ethnomedicinal herb of considerable culinary significance throughout Asia and the Mediterranean. Seeds were grown under three light conditions (i.e. full sunlight, partial shade, and complete darkness) to assess differences in germination rate, shoot: root length ratio, and leaf development over a 10-day period. A daily growth timeline is prepared. The results clearly demonstrated that light intensity plays a pivotal role in influencing seedling vigor and morphogenesis. Significantly, the strongest and most balanced growth was obtained under partial shade, indicating that a moderate light environment promotes the best possible physiological development by boosting photosynthetic activity and reducing photo inhibitory stress. In contrast, complete darkness prevented the leaf formation and elongated hypocotyls, which are signs of etiolation. These findings offer practical insights into how simple environmental manipulations can significantly affect plant growth outcomes. The study holds relevance for educators, researchers, and practitioners involved in sustainable agriculture, urban gardening, and botanical pedagogy, offering a scalable and accessible model for future experimentation in plant-environment interaction studies.

Keywords: plant development, light intensities, seedling vigor, environmental manipulations

Taxonomic and Ecological Study of some Polypodiaceous Ferns from the Darjeeling Himalaya

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ABSTRACT

Over the years, several authors have proposed classifications for ferns. However, significant revisions at the generic level have been suggested for some members of the family Polypodiaceae. The species within this family are often linked to complex lineages, which can make it challenging to understand the taxonomic relationships among them. This study examines the taxonomy and systematics of various Polypodiaceae species from the Darjeeling Himalayan region, with a focus on 25 selected species. Detailed morpho-anatomical traits were examined using light microscopy and scanning electron microscopy. Key traits considered included rhizome scales, stipes, lamina, venation, soral features, sporangia, and spore details. The traits were grouped based on their similarity and analyzed using principal component analysis to explore the covariance among the variables. The findings align with recent phylogenetic studies of the relevant genera, confirming the reliability and significance of morpho-anatomical and palynological research in fern taxonomy. The distribution pattern analyses revealed that the species composition changed markedly with altitude, and climatic variables, such as precipitation, humidity, and temperature, had a significant influence on the occurrence of Polypodiaceous ferns.

Keywords: Fern; Morpho-anatomy; Taxonomy; Polypodiaceae

Revelation of a Novel Xanthone Compound *β*-Mangostin, from *Garcinia cowa* Leaf Extract Exhibiting Potential Anti-Lung Cancer Activity

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ABSTRACT

The methanolic leaf extract of *Garcinia cowa* (Clusiaceae) has previously demonstrated strong anti-proliferative effects on A549 lung cancer cells. In this study, the bioactive fraction responsible for this activity was isolated and characterized using bioactivity-guided fractionation. LC-MS analysis identified cowaxanthones H, cowaxanthone, *β*-mangostin, and guttiferone F as constituents of the active fraction, with *β*-mangostin— a polyphenolic xanthone— being the most abundant. Commercial *β*-mangostin was then evaluated for its anticancer activity in A549 cells, along with its cytotoxicity toward normal cells. Treatment with *β*-mangostin significantly inhibited A549 cell proliferation, induced cell cycle arrest at the G0/G1 phase, and promoted apoptosis. These apoptotic effects were confirmed by AO-EtBr staining and DAPI-induced nuclear fragmentation. Mechanistic studies revealed that *β*-mangostin's apoptotic action involved increased intracellular ROS, mitochondrial membrane depolarization, and upregulation of caspase-3 and caspase-9. Importantly, *β*-mangostin showed limited cytotoxicity in normal cells. Collectively, these results emphasize the potent and selective anti-cancer properties of *β*-mangostin, supporting its potential as a promising therapeutic candidate for lung cancer therapy.

Keywords: *Garcinia cowa*; *β*-mangostin; Lung Cancer; Apoptosis; Bioactivity-guided isolation.

Study on Cytogenetic Diversity with special reference to Medicinal Plants of Berhampore Block, Murshidabad District

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ABSTRACT

Cytogenetics study includes the study of the chromosomes and the genetics which means heredity. Chromosomes are the condensed nucleoprotein fibres which are made up of DNA and histones. Cytogenetic diversity helps us to analyse the chromosome number, chromosome size, chromosome abnormality, aneuploidy and polyploidy. The study includes some of the medicinally important plants used by the people of Murshidabad, available in the Berhampore block. The study reveals about the chromosome number and also talks about the ploidy level, aneuploidy, abnormalities in the available species, along with the mitotic index which serves a distinguishing feature in cytogenetic study. The study helps us to analyse the chromosome number and structure of the chromosomes from the medicinal plants mostly belonging to the family of Liliaceae, Apocynaceae, Asteraceae. Cytogenetic study was mainly observed from the mitotic cells of the plant species. The cytogenetic diversity helps to analyse the chromosome number and which can be useful to create the chromosome count database and also useful in phytochemical profiling of the studied plant species.

Keywords: Cytogenetics; Chromosome number; Mitotic index; Phytochemicals.

Analyzing Mobile Health (mHealth) and its Potential: A Case Study on Attappady, Kerela

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ABSTRACT

India has experienced fastest growth in telecom in the world with its high population and development potential. On the other hand, prevalence of underweight children in India is among the highest in the world. According to World Bank report, India's Integrated Child Development Services (ICDS) requires to undergo considerable changes to address the malnutrition crisis in India. The use of mobile phone and wireless technologies to support the achievement of health objectives (mHealth) has the potential to transform the face of health service delivery across the globe (WHO). Nowadays, time, growing number of NGOs, donors and Governments started to merge mobile phones into their nutrition programmes. In India, Kerela Government (Health & Family Welfare Department) had taken the initiative for Attappady block, one of the largest tribal settlements in the state, situated in Palakkad district. The block came into highlight for shocking estimates of infant deaths mainly due to severe malnutrition during the year 2013. The mHealth initiative was launched in January, 2014 by developing two ICT based systems with GIS backbone, 'Jatak' to monitor growth of every child in all three nutrition parameters; namely wasting, underweight and stunting, 'Janani' to capture maternal services for safe delivery & to watch on Low Birth weight (LBW) babies. Objective of this paper is to study the impact of this mHealth initiative and its potential to combat against the silent killer, malnutrition. The analysis has been made using the real time data captured by Jatak and Janani software implemented in Attappady to ensure regular monitoring and tracking each under five children and mothers. The paper reveals that there is decline in the status of severe malnourishment as well as in total malnourishment, decline in the percentage of Severely or Acute Malnoutrished SAM children among total malnourished children, reduction in Ante Natal Check up (ANC) and Post Natal Check up (PNC) uptake failure, better immunization monitoring and lesser chance for underweight children to slip into SAM/ Moderately Malnourished MAM categories through generation of on-time alert.

Keywords: mHealth; Integrated Child Development Services (ICDS); severely or acutely (SAM) malnourished child; moderately (MAM) malnourished child.

Molecular Discrimination of Commercial Squid Varieties using PCR-Based 5s rRNA With Non-Transcribed Spacer (NTS) Region for Seafood Authentication

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ABSTRACT

Seafood fraud, particularly mislabelling of economically valuable cephalopods, is a significant concern in global fisheries. This study utilises molecular markers to discriminate among three commercial cephalopod species—*Sepia* sp., *Uroteuthis duvaucelii*, and *Euprymna hyllebergi*. Samples collected from the Pazhayar fish landing centre were processed through genomic DNA extraction using the phenol-chloroform method. PCR amplification targeting the 5S rRNA gene with its non-transcribed spacer (NTS) region produced distinct banding patterns for each species. *Sepia* sp. displayed three bands (147, 287, 430 bp), *U. duvaucelii* exhibited a single uncut band (347 bp), and *E. hyllebergi* showed two bands (285 and 586 bp). The results demonstrate the potential of 5S rRNA-based PCR for accurate species authentication, thereby supporting seafood traceability, conservation, and regulatory compliance.

Keywords: Cephalopods; PCR, 5S rRNA; Non-transcribed spacer; Seafood authentication; *Sepia*; *Uroteuthis*; *Euprymna.*

From Tolerance to Turmoil: A mesocosm-based hierarchical modelling approach to decode the synergistic impacts of temperature rise and pesticide pollution on meiobenthic communities in two different coastal ecosystems along the Bay of Bengal

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ABSTRACT

In the age of anthropocene, climatic chaos meets chemical fallout and marine ecosystems face a hidden catastrophe**.** Meiobenthic organisms are sensitive bio-indicator and offer crucial insights into ecosystem responses under such stressful conditions. However, they are often overlooked despite their importance in ecosystem functioning. In this study, a 10-day acute mesocosm experiment explored the combined effects of elevated temperature (34°C) and chlorpyrifos contamination (3 and 4.5 μgL^{-1}) on meiobenthic organisms from two contrasting coastal habitats-intertidal sandflats and mangrove mudflats. The results revealed steep declines in total meiobenthic abundance, up to 75% and 73% in mangrove mudflat and intertidal sandflat respectively. Sensitive groups such as Kinorhyncha, Bivalvia, and Ostracoda were entirely eliminated under dual stress exposure. Nematode abundance decreased up to 65% and 63% in the mangrove-mudflat and intertidal-sandflat, correspondingly. Biodiversity indices, including species richness, Shannon–Wiener Index, Maturity Index (MI), and Index of Trophic Diversity (ITD), reflected significant community degradation. Notably, species composition shifted toward opportunistic and stress-tolerant nematodes, indicating ecological instability. Hierarchical Modelling of Species Communities (HMSC) pinpointed habitat type, exposure duration, and stressor intensity as key determinants of community sensitivity. Mangrove systems showed marginally higher vulnerability compared to sandflats. This integrative approach provides valuable perspectives in predicting benthic biodiversity and ecosystem health under future stressful scenarios driven by climate change and other anthropogenic perturbations.

Keywords: Chlorpyrifos; Nematodes; Multi- stressors; Biodiversity.

Tides of Stress: Dual Impact of Ocean Warming and Acidification on Energetic and Oxidative Balance in *Etroplus suratensis*

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ABSTRACT

The incessant release of anthropogenic CO_2 has significantly exacerbated physiological disruptions in marine fauna. Although ocean warming (OW) and ocean acidification (OA) are recognized as pivotal stressors, their synergistic consequences on teleost fish remain elusive. The Intergovernmental Panel on Climate Change (IPCC) predicts a decline of 0.3–0.4 pH units and an elevation of 1–4°C in sea surface temperature by the end of this century. Against this backdrop, the present study sought to unravel the eco-physiological resilience of *Etroplus suratensis* under co-occurring OW and OA over a 30-day mesocosm experiment. Fish were exposed to four regimens: (a) current scenario (pH 8.1, 28°C), (b) acidification stress (pH 7.7, 28°C), (c) warming stress (pH 8.1, 34°C), and (d) projected future scenario (pH 7.7, 34°C). Physiological metrics such as ingestion, assimilation, respiration, and excretion were assessed to calculate Scope for Growth (SfG), alongside oxidative stress biomarkers.

Results revealed that combined stressors conspicuously curtailed ingestion and assimilation. Metabolic depression, evident from suppressed respiration and excretion, implied an energy conservation strategy. The decline in SfG indicated compromised energy allocation. Antioxidant enzymes (SOD, CAT, GST) increased significantly, yet proved inadequate to counter prolonged oxidative insult, as reflected by elevated lipid peroxidation (LPO). Collectively, OW and OA severely disrupt energy balance and redox status in *E. suratensis*, potentially threatening future population stability.

Keywords: Ocean warming; Ocean acidification; Scope for growth; Oxidative stress biomarkers.

Fortification of Ornamental Goldfish (*Carassius auratus L*) Feed with Palash Flower (*Butea monosperma*): A Natural Approach to Enhance Pigmentation

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ABSTRACT

Ornamental fishes display vibrant red, orange, or yellow hues due to carotenoid pigments, making them visually appealing. However, in captivity, their colouration often fades. One naturally occurring source of carotenoid is the palash flower (*Butea monosperma*), also referred to as the **Flame of the forest**. Palash flowers are locally available in season (March–May) in the West Bengal districts of Purulia, Bankura, and Midnapore. Many flowers at that time were strewn all over the ground and squandered because they weren't being used. The study evaluated the effect of powdered palash flower as a natural carotenoid source on Goldfish pigmentation over a 60-day aquarium-based experiment involving six groups. Fish were fed 4% of their body weight twice a day. Experimental diets were prepared with Palash flower powder incorporation in different graded levels: T2 (2.5%), T3 (5%), T4 (7.5%), T5 (10%), along with control feed (T1) and commercial feed (T6). To prepare the experimental feed, Pearson's square method was used. The concentration of pigment was measured using the UV spectrophotometry method (Olson, 1979). The T4 tank showed the best results in skin pigment concentration, showing a significant difference compared to other tanks, as indicated by a p-value <0.05. As an alternative natural carotenoid source, the current findings show that a diet of Palash flower petal powder helps maintain the body pigmentation of Goldfish.

Keywords: Goldfish; Palash flower; Pigmentation; Colouration.

Biology and Captive Breeding of the Indian Freshwater Ornamental Green Rocket Shrimp *Caridina hodgarti* (Kemp, 1913)

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ABSTRACT

Caridina hodgarti, commonly known as the Green Rocket Shrimp, is a vibrant ornamental freshwater shrimp native to the Brahmaputra Valley and the Himalayan foothills. This study investigates its biology, feeding behaviour, and captive breeding potential, aiming to promote conservation and sustainable aquaculture. The species demonstrates omnivorous feeding habits, with a marked preference for spirulina-based artificial diets. Morphometric and meristic analyses revealed a strong positive correlation between body length and rostrum length in females. Reproductive investigations indicated early sexual maturity (~1–2 months), year-round spawning, and a fecundity range of 29–61 eggs. Successful captive breeding was achieved through environmental modulation and dietary trials. Embryonic development occurred over 12–14 days at 24°C, passing through three larval stages before reaching the juvenile phase. Water quality parameters were maintained within optimal limits throughout. This is the first comprehensive captive rearing protocol for *C. hodgarti*, highlighting its viability for ornamental aquaculture while reducing pressure on natural populations.

Keywords: *Caridina hodgarti*; Ornamental shrimp; Biology; Breeding.

Comparative Toxicological Assessment of Commercial Detergents on *Poecilia sphenops*: Mortality, Behavioural, and Physiological Responses

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ABSTRACT

Environmental pollution from household detergents has emerged as a pressing concern in aquatic ecosystems. This study evaluates the acute and sub-lethal toxicity of two commercial laundry detergents—Ariel Perfect Wash and Surf Excel Easy Wash—on the black molly (*Poecilia sphenops*), a popular ornamental fish. Fingerlings were exposed to graded concentrations of each detergent for 48 hours, and mortality, behavioural anomalies (loss of balance, rapid movement), and physiological changes (gill damage, opercular irregularities) were recorded. LC_{50} values calculated using the Miller and Tainter probit method indicated that Surf Excel Easy Wash was more toxic (29.28 ± 2.8 ppm at 12 h and 20.92 ± 3.4 ppm at 24 h) than Ariel Perfect Wash (46.74 ± 4 ppm at 12 h and 41.57 ± 3 ppm at 24 h). Acclimatised specimens demonstrated better tolerance compared to non-acclimatised groups. The results underline the urgent need to monitor detergent effluents and support stricter ecological regulations to mitigate aquatic toxicity.

Keywords: *Poecilia sphenops*; Detergent toxicity; LC_{50}; Swimming behaviour, Gill damage, Ariel; Surf Excel; Aquatic pollution.

Molecular Identification of Tick Species in Cattle Population from Three Northern Districts of West Bengal

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ABSTRACT

One of the major factors affecting the health of cattle is the presence of ectoparasites on their body. Ectoparasites of cattle include ticks, mites, fleas, lice, etc. The prevalence of ticks in a specific area is also a matter of great concern, as they act as vectors for transmitting haemoprotozoal, rickettsial, bacterial, and viral diseases in livestock, some of which are of zoonotic importance. A survey was carried out to recognize the presence of ticks in cattle in the Jalpaiguri, Darjeeling, and Alipurduar districts of West Bengal, India. During the survey from January 2021 to December 2022, a total of 1168 cattle were examined from different villages in three districts, and 372 cattle were noticed to be infested. The ticks from the cattle were collected in 70% and 90% ethanol for identification. For morphological identification stereo-microscopic study was carried out, whereas a mitochondrial 16S rRNA gene segment amplification procedure was performed for molecular diagnosis. The amplified fragments were sequenced and subsequently aligned with identical sequences using NCBI BLAST. Aligned files were then subjected to the formation of a phylogenetic tree by the neighbor-joining method in MEGA-11 software. Six tick species were identified using a stereo-microscope, and for the first time, these tick species were confirmed on a DNA sequence basis from the three districts of West Bengal. The identified tick species were *Haemaphysalis cornigera, Haemaphysalis obesa, Haemaphysalis lagrangei*, *Haemaphysalis bispinosa*, *Amblyomma testudinarium*, and *Rhipicephalus microplus.*

Keywords: Cattle; Molecular identification; Tick; West Bengal.

Effects of Food Waste Peel Powders on Carotenoid deposition, Growth, Feed Utilization, and Health Parameters in Goldfish (*Carassius auratus*)

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ABSTRACT

The increasing food waste rate in modern societies presents both environmental challenges and sustainable aquaculture growth opportunity. This current research explores the potential of using waste fruit and vegetable peels—onion skin, sweet lime peel, and pumpkin peel—as natural sources of carotenoids in ornamental fish feed production. A 60-day feeding trial on goldfish was conducted to evaluate the performance of adding these food waste materials at a level of 5g/100g feed in a 30% protein diet in carotenoid-induced coloration, growth, feed intake, and health status. The research indicates that the utilization of food waste-based carotenoids is capable of reducing feed cost approximately 82%. Carotenoid deposition in fish tissues was significantly elevated in the peel powder groups, with pumpkin peel diet showing the highest accumulation rate of 60.11%, followed by sweet lime peel and onion skin diets. Growth performance and feed utilization parameters including weight gain, length gain, specific growth rate, feed conversion ratio and protein efficiency ratio remained comparable across all peel powder incorporated diets but showed significant difference in fish receiving control and commercial diet compared to peel powder incorporated diets. Haematological analyses revealed significant differences in key health indicators such as hemoglobin concentration, red blood cell count, hematocrit, and other relevant parameters, indicating improved physiological status due to bioactive compounds in peel powder diets. Overall, these findings support the viability of converting carotenoid-rich food waste peels into high-value aquafeeds, so contributing to circular economy goals in ornamental aquaculture.

Keywords: Food waste; Goldfish; Carotenoids; Sustainable aquafeed.

Omics-Guided Insights into Malnutrition: A Bioinformatics Perspective

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ABSTRACT

Malnutrition—spanning both deficiencies and excesses in nutrient intake—remains a major health issue globally, especially in low-resource regions. Its development is influenced by a web of factors, including dietary habits, genetic predisposition, metabolic pathways, and environmental exposures. As a result, conventional diagnostic and treatment strategies often fall short. Recent progress in omics technologies, coupled with advancements in bioinformatics, has significantly improved our ability to investigate the biological foundations of malnutrition. This study examines the pivotal contributions of bioinformatics in analyzing genomic, transcriptomic, metabolomic, and microbiomic data related to nutritional imbalances. Genomic and transcriptomic tools help uncover genetic risk markers and disruptions in gene activity, while metabolomics provides insights into nutrient-dependent metabolic alterations. Moreover, research into gut microbiota has clarified its role in nutrient assimilation and immune regulation. By integrating these diverse omics datasets, bioinformatics supports early detection, individualized nutritional plans, and targeted public health initiatives. We also discuss the growing use of artificial intelligence and mobile technologies for dynamic, real-time nutritional monitoring. Embracing a systems biology perspective, this approach offers a more comprehensive framework for addressing malnutrition and supports the development of both personalized and population-level solutions.

Keywords: Malnutrition; Bioinformatics; Omics; Systems Biology.

A Cross-sectional Study on the Effect of Psychological Stress on Working Memory of University Students of Diamond Harbour

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ABSTRACT

Working memory (WM) can be affected by several factors, e.g. genetics, psychological stress (PS), different hormones, sleep, exercise etc. Among all the factors affecting WM, PS is the most vulnerable but modifiable factor. The aim of the study was to find out the effect of PS on WM of university students of Diamond Harbour, West Bengal, India. A total of 188 university students (92 boys & 96 girls) were surveyed during the study. PS and WM were assessed from perceived stress scale and an online working memory test respectively. SPSS (Version 23.0) was used for statistical analyses. Students were categorised in 3 categories of stress level i.e. low, moderate and high depending on the scores of stress scale. It has been found that the students belonging to low PS category scored significantly higher in the test of WM than that of the students who belong to moderate and high PS category ($p<0.05$). It was also found from the Pearson's correlation that WM has a negative and significant correlation ($p<0.05$) with PS. Moreover, it was evident from the study that the hostellers had significantly higher psychological stress than that of the day scholars ($p<0.05$). Therefore, it can be concluded from the current study that working memory has a strong negative correlation with psychological stress.

Keywords: Psychological stress; Working memory; University students.

Binocular Vision Status and Psychological Behaviour Among Children with Dyslexia Pre and Post Vision Therapy

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ABSTRACT

Vision therapy has been shown to enhance visual processing, eye movements, and visual attention, positively influencing reading ability and psychological well-being in children with dyslexia. Improvements in visual processing, attention, and confidence contribute to better psychological outcomes.

To evaluate the effectiveness of vision therapy in improving binocular vision parameters and psychological behaviour in children with dyslexia.

A convenience sampling method was used to select and assess a group of 34 children with dyslexia in order to fulfil the aim and purpose of the study. Ages ranging from 7 to 15 were included in the study. Binocular vision parameters and psychological behaviour were assessed at baseline, 3 months, and 6 months. Participants received vision therapy throughout the study period.

Total participants 34 (19 males & 15 females) consist of NSBVD as follows, Convergence insufficiency 09 (26.47%), Convergence excess 02 (5.88%), Accommodative insufficiency 15(44.11%), Accommodative infacility 04 (11.74%), Divergence excess 04 (11.74%). As the vision therapy continues there is improvement in the Binocular vision parameters. Significant improvements were observed in psychological behaviour (Chia T-scores), Baseline vs 3 months ($p<0.05$),3 months vs 6 months ($p<0.05$), Baseline vs 6 months ($p<0.05$) Which is relatively improving after the vision therapy. Vision therapy significantly improved binocular vision and psychological behaviour in children with dyslexia, highlighting the importance of early detection and treatment of NSBVD.

Keywords: Dyslexia; NSBVD; Psychological behaviour; Vision therapy.

Pulmonary Function of Rubber Industry Workers of West Bengal, India

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ABSTRACT

The aim of the present study is to evaluate the respiratory status of rubber industry workers and the risk factors associated with respiratory symptoms. This cross-sectional study was conducted with 170 rubber industry workers and 100 control group individuals from West Bengal by simple random sampling method. Pulmonary function parameters were assessed by digital spirometer and Peak Flow Meter. Pulmonary function parameters were significantly declined in rubber industry workers compared to controls**.** Age, smoking habit and year of exposure were found to be the causative factor for reduction in pulmonary functions. Significant detrimental effects were found in workers of different departments of this industry for the above parameters with a maximum reduction in mixing department workers. Crude odds ratio values indicate significant correlation between respiratory symptoms (chronic cough, chronic bronchitis and chest tightness) with age, smoking habit and year of exposure. But AOR values indicate significant association with smoking habit and chronic cough symptoms. 38.82% of rubber industry workers have restrictive type of respiratory impairment compared to control group. These results indicate that respiratory impairments are associated with high dust exposure and chemicals which can be controlled by introduction of modern technologies, use of protective gadgets, rotation of work schedule and periodic health check-up.

Keywords: Rubber industry workers; Pulmonary function; Respiratory impairment; Odds ratio; Restrictive lung disease.

Alteration of Haematological and Cardio-Vascular Parameters among Petrol Filling Workers of West Bengal, India

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ABSTRACT

This study aimed to investigate the effects of volatile organic compounds exposure on blood and cardiovascular parameters of Petrol station workers of West Bengal. The study included 153 male Petrol station workers and 50 control group individuals having age range 20-60 years. Different haematological and cardiovascular parameters have been evaluated. Blood samples were collected and analysed by automated haematology analyser. The analysis of the results showed significant haematological changes in exposed workers and 21% workers were anaemic. Haemoglobin concentration and RBC count decrease significantly but significantly higher neutrophil, ESR and eosinophil count were observed compared to the control group. Besides, significantly higher heart rate, systolic and diastolic blood pressure was found in exposed group indicating cardiovascular risk. ESR and Neutrophil-Lymphocyte ratio (NLR) values increased maximum above 20 years and between 11-20 years of exposure respectively. This high NLR value is associated with anaemia and hypertension among petrol filling workers. Thus, NLR value can be used in routine clinical assessment of anaemia and hypertension. Thus, health of workers should be protected by introduction of petrol vapour recovery system and minimizing leakage and spillage, wearing protective gadgets and health awareness to these workers.

Keywords: Petrol filling workers; Haematological parameters; Cardiovascular parameters; BTEX; Neutrophil –Lymphocyte ratio (NLR).

Physiological Strain and Dehydration Risks among Male Agricultural Workers during Summer Paddy Harvesting in Eastern India: Implications of Climate Change

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ABSTRACT

Escalating climate change has intensified heat exposure risks, especially for agricultural workers in tropical regions. This study aimed to assess physiological heat strain and dehydration risks among male paddy harvesters in eastern India during summer. A cross-sectional field investigation was conducted on 200 male harvesters (18-55 years old) over 40 days (April–June 2024) in West Bengal, India. Hourly Wet Bulb Globe Temperature (WBGT) was recorded during work shifts. The Physiological Strain Index (PSI) was computed using heart rate and aural canal temperature. Pre- and post-work hydration status was assessed via urine specific gravity (USG). Regression models were developed to identify predictors of PSI. PSI increased progressively during work, correlating strongly with WBGT ($r \geq 0.609$; $p < 0.001$). WBGT was the most significant predictor of PSI across all regression models. Age and smoking habit were positively associated with heat strain, while work experience had a protective effect. Dehydration prevalence significantly increased from 16.5% to 33% post-shift ($p < 0.001$). Participants with excessive sweating had a 2.35-fold higher risk of dehydration (PR = 2.35; 95% CI: 1.53–3.61). The findings provide compelling evidence of cumulative heat strain and fluid loss during summer paddy harvesting, highlighting the urgent need for heat-adaptive interventions, including rest, shade, and hydration.

Keywords: Heat strain; Harvesters; Urine specific gravity; WBGT.

Exploring the Ameliorative Potential of Melatonin on Arsenic Induced Oxidative Stress Mediated Damages in Erythrocytes: A Molecular Approach

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ABSTRACT

Arsenic, 20th most common natural element of earth's crust, is recognised as a toxic metalloid and non-essential heavy metal. Previous mechanistic studies have documented arsenic as an oxidative stress inducer through free radical generation, which potentially causes physiological complications. However, its haematological impacts remain poorly understood, although arsenic gets in direct contact with blood through absorption of water or food stuffs containing arsenic. Erythrocytes, the unique cell lacking nucleus and other subcellular metabolic structures, are particularly vulnerable to oxidative damage due to their high oxygen exposure and haemoglobin content. The pineal hormone melatonin, which is naturally present in various easily accessible food sources have long been employed as a potential antioxidant having free radical scavenging ability. Pharmacological studies have indicated melatonin as well-tolerated in humans without significant side effects. In this context, it is highly demanding to determine whether arsenic exposure alters erythrocyte structure and function due to oxidative stress mediated toxicity and whether melatonin confers any protective effect against them. The present study demonstrated significant impairments in the oxidative stress biomarkers, key antioxidant and metabolic enzyme activities by arsenic subjection. Increased erythrocyte fragility, Heinz body content and notable morphological disruptions were also observed. Co-treatment with melatonin effectively ameliorated all these alterations, restoring them toward control levels. These findings highlight melatonin as a potential therapeutic agent against arsenic-induced erythrocyte toxicity.

Keywords: Oxidative stress; Arsenic; Erythrocyte; Melatonin.

Disordered Eating Behaviors and Their Correlates Among Female Students: A Cross-Sectional Study

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ABSTRACT

Eating disorders are psycho-physiological disorders involving abnormal eating behaviors that lead to serious health problems. Adolescence is a critical stage with increased risk for eating disorders, which significantly affect physical and mental well-being. The aim of this study was to explore the occurrence and correlates of disordered eating behaviors among female students. A cross-sectional study was performed on approximately 135 female college students, aged (18 and 25 years), from the Nadia district. Data collection encompassed measurements of various physical parameters, including height, weight, body mass index (BMI), waist-to-hip ratio, and body fat composition. Individual chronotype, eating behaviour, psychological well-being (depression, anxiety, and stress), dietary intake and sleep quality were assessed. Statistical analyses were performed using the Kruskal-Wallis test (at $p < 0.05$) and Spearman's correlation method. Based on the responses from EAT-40 subjects were divided into three groups 1. Healthy Eating (50.37%), 2. At-Risk (35.56%), and 3. eating disorder (14.07%). A Significant association was found between higher EAT scores and several physiological and psychological parameters, and also with nutrient intake among the groups. A significant proportion of subjects exhibited disordered eating behaviors associated with nutritional deficiencies and psychological distress. Early detection and targeted interventions are crucial for prevention of this disordered eating patterns during this vulnerable period.

Keywords: Eating patterns, eating disorder, sleep quality, psychological distress.

Predicting the Impact of Missense Mutations of Suppressor of Zeste 12 (SUZ12) Subunit of Ploycomb Repressor Complex 2 and its Relationship to the Tumor Microenvironment.

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ABSTRACT

The polycomb group (PcG) proteins are epigenetic modifiers and transcriptional regulators and are essential players in cellular identity. They were initially identified as transcriptional repressors of homeotic (HOX) genes in genetic screens in Drosophila. PcG proteins are highly conserved throughout metazoan evolution. PcG proteins form two main epigenetic complexes, the Polycomb Repressive Complex 1 and 2 (PRC1 and PRC2). These complexes are involved as transcriptional regulators targeting a large number of genes. Human PRC2 consists of four core subunits: (i) Enhancer of zeste homolog 2 (EZH2), (ii) Embryonic Ectoderm Development (EED), (iii) Suppressor of Zeste 12 (SUZ12), and (iv) Retinoblastoma suppressor Associated Protein 46/48 (RbAp46/48) and several auxiliary subunits. SUZ12 was found to be essential for PRC2-mediated gene silencing by generating trimethylation on lysine 27 residue of histone H3 (H3K27me3). Furthermore, SUZ12 was appreciated as a putative oncogene or tumour suppressor underlying tumorigenesis. We have found that SUZ12 is overexpressed in several cancers including colorectal, ovarian and non-small lung cancer. Its aberrant overexpression is found to be significantly associated with survival outcome. It was reported that loss-of-function somatic alterations of SUZ12 was identified in malignant peripheral nerve sheath tumours. Our computational analyses have predicted several damaging and deleterious missense variants in human SUZ12.

Keywords: SUZ12; Missense variants; Cancer; Epigenetic regulation.

Respiratory Morbidity and Alteration of Biochemical Parameters among Male Workers in the Conch Shell Industry: Impact of Occupational Dust Exposure

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ABSTRACT

The conch shell craft sector, a culturally significant yet unregulated industry in West Bengal, exposes workers to chronic inhalation of fine calcium carbonate dust. Despite its traditional importance, the associated occupational health risks remain largely underrecognized. This study aimed to assess respiratory health outcomes and cellular stress indicators among male conch shell workers. A total of 250 workers aged 25 years and above were surveyed in 2025 from Murshidabad, North 24 Parganas, and Kolkata, alongside sales staff (2:1) as a control group. Respiratory morbidity was evaluated using a modified version of the European Community Respiratory Health Survey (ECRHS), and lung function was assessed through spirometry. In a subset, sputum samples were analyzed for cell viability using trypan blue exclusion, and oxidative stress biomarkers were measured to assess systemic stress. Results indicated significantly higher respiratory morbidity among exposed workers. Spirometry revealed notably lower FEV_1 and FEV_1/FVC ratios in the exposed group compared to controls. Additionally, reduced sputum cell viability and elevated oxidative stress markers were observed among the exposed workers, suggesting cellular and systemic impacts of chronic dust exposure. These findings underscore the need for urgent intervention, including proper ventilation and personal protective equipment, to reduce respiratory and systemic health risks in this vulnerable occupational group.

Keywords: Conch Shell; Spirometry; Oxidative stress.

Assessment of Workplace Ergonomics and Postural Practices in Corporate Office Environments

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ABSTRACT

Workplace occupational hazards have emerged as a significant focus within Ergonomics and Occupational Physiology research, particularly regarding both immediate and long-term health implications for office personnel. Employment that primarily involves desk-based activities often promotes sedentary behaviour patterns, which may contribute to obesity and associated health complications. Additionally, extended periods of maintaining static seated positions combined with inadequately designed ergonomic workstations can result in Work-related Musculoskeletal Disorders (WMSDs) among employees who utilize computer workstations. Consequently, the present ergonomic study examined 200 male office employees from corporate sectors of West Bengal through structured interviews assessing somatic pain prevalence utilizing the Modified Nordic questionnaire, Body Part Discomfort Scale, and postural analysis methodologies and Rapid Office Strain Assessment method to evaluate the office workstation, while body fat composition evaluation was also conducted using Bioelectrical Impedance analysis. This study revealed a significant prevalence of elevated body fat percentages, indicating a pronounced tendency toward obesity within the study population. Furthermore, preliminary manifestations of WMSDs demonstrated statistically significant correlations with Body Mass Index, in conjunction with the adoption of biomechanically disadvantageous working postures among office workers.

Keywords: WMSDs; Office Workers; Obesity; Posture.

Antioxidant Intervention in BPA-Induced Duodenal Impairment: Efficacy of Ascorbic Acid

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ABSTRACT

Bisphenol A (BPA), a widely used industrial chemical, is known to induce oxidative stress by generating reactive oxygen species (ROS), thereby disrupting normal physiological functions. While its neurotoxic effects have been well studied, limited data are available on BPA's impact on gastrointestinal motility. This study explores the potential protective role of ascorbic acid against BPA-induced inhibition of duodenal movement in rats. Experimental groups included for this study are: BPA, BPA + ascorbic acid, DMSO (vehicle), and DMSO + ascorbic acid, with oral administration for 20- and 30-day treatment durations. Rats were sacrificed 24 hours post-treatment, and duodenal smooth muscle tissue homogenates were used to measure antioxidant enzyme activity (like SOD, CAT, GPx, GR, GST) and lipid peroxidation via malondialdehyde (MDA) production levels. BPA exposure significantly reduced the activities of SOD, CAT, GPx, and GR, elevated GST activity, and increased MDA production, indicating oxidative damage. However, co-administration with ascorbic acid prevented these alterations, restoring enzymatic balance and reducing lipid peroxidation. These results suggest that BPA inhibits duodenal movement through oxidative stress, and ascorbic acid effectively mitigates these effects by enhancing the cellular antioxidant defense system.

Keywords: Bisphenol A (BPA); ascorbic acid; oxidative stress; duodenal motility.

Preventive Role of Black Tea Extract (BTE) on Endosulfan Induced Altered Intestinal Calcium Transference of Ovariectomized Rats

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ABSTRACT

With the expansion of agriculture, pesticide use is rapidly increasing in developing countries. Endosulfan, a polycyclic chlorinated hydrocarbon insecticide is a broad-spectrum compound used widely to control a variety of pests in agriculture and is commonly used to control the insects on cocoa, coffee, cashew, tobacco, and cotton plants. Endosulfan is a GABA-gated chloride channel antagonist and also inhibits Ca2+, Mg2+ ATPase. Black tea consumption has been shown to be useful for prevention of many debilitating human diseases that include maintenance of cardiovascular and metabolic health. It has also been reported to increase serum basal estradiol level in oophorectomized rats. The present study was designed to investigate the potential of black tea extract on calcium transference of endosulfan treated ovariectomized rats. Endosulfan at a dose of 5 mg/kg body weight/day in ovariectomized rats were able to decrease calcium transference along with Ca2+ ATP ase activity where as additional supplementation with black tea extract (BTE) at a dose of (2.5 gm%) (1ml/100gm of body weight/day) orally for 30 days could reverse the situation. Altered antioxidant enzyme status of duodenal cells in endosulfan treated rats were also reversed after BTE supplementation and a positive correlation was observed with revival of serum estradiol level and duodenal cell antioxidant status in BTE treated rats. Thus, black tea extract exerts ameliorative effect against endosulfan mediated altered calcium transference in ovariectomized rats.

Ergonomic Evaluation of a Passbook Printing Kiosk and Probable Redesigning Ideas

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ABSTRACT

Ergonomics is the science of designing systems so that the productivity is enhanccd while optimizing the user health and safety. With the boom in personal banking, the use of ATMs and passbook printing kiosks have increased in the last decade and a half. This study aimed at evaluating the existing passbook printing kiosks in terms of its display and control unit and provide a redesign idea for improvement. One to one questionnaire survey was done to understand the user bahaviour. Users were observed while using the passbook printing kiosk, video recording were done and analysed later. A Total of 217 users from age group ranging from 15 years to 55 years participated in this study. Few of the problems that were identified were complicated user interface, no proper instruction manual, paper jam, illegible fonts and background colors with bad contrast. For redesigning phase brain stroming sessions were conducted with various stakeholders and finally mock desing ideas were sketched. Few prototypes were developed and tested. Few of the solution for improvements are use of passbook image in the printing area for proper allignment, cleaner user interface with minimal distractions, use of proper backgroud colors and fonts etc.

Keywords: Product design; Industrial design; Ergonomics; User interface.

Prediction of Nutritional Status from Skinfold Thickness in Undernourished Slum Children of Kolkata, India

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ABSTRACT

The present study was undertaken to explore whether the skinfold thickness can be used in assessing the nutritional status in 5-10 years aged slum children of Kolkata of West Bengal and to determine the sensitivity of these parameters for measuring the nutritional status. Height, weight and skinfold thickness of triceps (TRSF), biceps (BCSF), suprailiac (SPSF) and subscapula (SBSF) of slum children were measured. Mean values of TRSF, BCSF, SPSF and SBSF for girls are significantly ($p<0.05$) higher than boys at all age groups. Growth curves of TRSF-for-age and SBSF-for-age in slum children are placed at lower level of reference values indicating prevailing undernutrition in surveyed children. The SBSF for boys and TRSF for girls are significantly associated with nutritional status. Present study suggests that SBSF for boys and TRSF for girls are more sensitive than other skinfold thickness for the assessment of nutritional status in slum children. Relationship of growth pattern of skinfold thickness is different in undernourished slum children compared to well-nourished slum children.

Keywords: Slum; Skinfold thickness; Undernutrition; Nutritional status.

The Olfactory Organ of Schilbid Catfish, *Eutropiichthys vacha* (Hamilton, 1822): Gross Morphology and Fine Structure

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ABSTRACT

The olfactory organ plays a vital role in various behaviours of teleosts. In the present study, the structural and functional aspects of different cell types in the olfactory organ of *Eutropiichthys vacha* (Siluriformes: Schilbeidae) were examined using light microscopy, as well as scanning and transmission electron microscopy. The paired, elongated olfactory organs were located on the dorsolateral surface of the head in the form of simple pits. Each organ consisted of a series of leaf-like lamellae embedded on both sides of a slender midline raphe, forming a rosette that exhibited distinct sensory and nonsensory regions. Each lamella was composed of two epithelial layers enclosing a central core, which contained fibrous connective tissue, nerve fibers, blood vessels and a few pigment cells. Olfactory cells were distinguished based on their staining properties, morphology, surface features and distribution patterns within the olfactory mucosa. The sensory epithelium was populated with anatomically distinct ciliated, microvillous and rod receptor cells that receive olfactory stimuli from the aquatic environment. The nonsensory epithelium comprised mucous cells, labyrinth cells, mast cells and two types of supporting cells, categorized as either ciliated or nonciliated. Basal cells were situated deep within the olfactory lining, near the central core. The cellular composition of the olfactory organ is discussed in the context of its role in the fish's chemosensory system.

Keywords: Vacha fish; Olfactory structure; Histology; Ultrastructure.

Comparative Analysis of Waterbird Assemblage in Two Floodplain Wetlands of Southern West Bengal, India.

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ABSTRACT

Present study was conducted to access the diversity, abundance and richness of waterbird population in two floodplain wetlands, *viz.,* Purbasthali beel (23° 27′ N and 88° 20′E) and Hansadanda beel (23° 27′N and 88° 27′E) of southern West Bengal (India). This comparative study was also carried out to determine the present ecological status and to establish an avian species checklist of the said areas. It is obvious that the birds play a vital role as bio-indicator to minor changes in the adjacent environment. In this context, the current study is crucial to comprehending the biodiversity and ecological conditions of the water areas. The study was conducted from January 2023 to December 2023, for a total of one year. In both sites, family- Anatidae was found to be the most prevalent and to have the largest relative diversity. Different diversity indices like Shannon, Simpson and Margalef were considered to determine the abundance, diversity and richness of waterbird population. Different limnochemical parameters, environmental and anthropological intimidations were also investigated in order to comprehend the current situation.

Keywords: Floodplain wetlands; Waterbirds; limno-chemical parameters; environmental threats.

Forms and Functions of Fish Macrophages

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ABSTRACT

One of the most competent phagocytes in teleost is found to be macrophages. Macrophages are best known for their role in defensive mechanism. Fish macrophages arise from the head kidney which is treated as haematopoietic progenitor and differentiate into tissue macrophage. Alive fish samples of tilapia (*Oreochromis* sp.) and rohu (*Labeo rohita*) were collected from local markets and tissues from head kidney, spleen and liver were collected and mashed in (0·1) M phosphate buffer saline (pH 7·2) in presence of trypsin- EDTA. From cell suspension, adherent macrophages on glass slides were stained by Giemsa. Activated charcoal particles was used for phagocytosis study. Tissues were processed for histological examination. Inflammatory cells from the swim bladder (SB) were also studied. Result showed numerous free macrophages with pseudopodia or macrophage aggregates (MAs) on glass slides. Melano-macrophage centers (MMCs) or macrophage aggregates were found in tissue sections during H-E staining. Melano-macrophage centres increase in size or frequency in different stressed conditions, diseases and have been used as reliable biomarkers for pollution. Understanding of teleost macrophages would not only help to indicate the immunity in fish but will also help in prevention of infectious diseases.

Keywords: Teleost; Macrophages; Macrophage Aggregates; Melano-macrophage centers.

Fish Biodiversity as a Bioindicator of Aquatic Health: A Case Study from Jalangi River

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ABSTRACT

Rivers play a pivotal role in sustaining aquatic biodiversity and supporting livelihoods through fisheries. The Jalangi River, a vital tributary of the Ganga in West Bengal, harbours significant ichthyofaunal diversity and serves as a crucial resource for local communities. This study was conducted to assess the fish diversity and ecological status of the river stretch near Kadamtala Ghat, focusing on its relationship with key physicochemical parameters of water. The work adopts standard ecological and statistical methods to evaluate species diversity, richness, and evenness, aiming to understand the health and sustainability of the river ecosystem. Seasonal patterns in fish assemblages were observed and interpreted in relation to water quality variables, providing insights into the ecological dynamics of this lotic system. The findings highlight the importance of continuous ecological monitoring and the role of aquatic biodiversity as a bioindicator of water quality. This study also underscores the potential threats posed by anthropogenic activities and the necessity of informed management strategies to conserve aquatic habitats. The outcome contributes to regional biodiversity documentation and forms a baseline for future ecological assessments and sustainable resource utilization.

Keywords: Fish Diversity; Jalangi River; Aquatic Ecosystem; Water Quality.

A Comprehensive Study of the Changing Socio-Economic Conditions of the Fishermen of Indian Sundarban Highlighting Adaptations and Resilience

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ABSTRACT

The socio-economic study of the Indian Sundarban highlights the severe challenges faced by fishing communities whose livelihoods are intricately linked to this fragile ecosystem. In recent years, their living conditions and economic stability have been deeply affected by recurrent tropical cyclones, frequent floods, and other natural calamities, making the Sundarban one of the most vulnerable coastal regions. Climate change has exacerbated these issues, with rising sea levels, coastal flooding, unpredictable weather, and an increased frequency of cyclones severely disrupting fishing activities. Fishermen suffer from the loss of fishing grounds, damaged equipment, and heightened safety risks, while external pressures such as urbanization, industrialization, and the COVID-19 lockdown of 2020 have further strained their already fragile socio-economic base.

A detailed field study conducted in four blocks of the Sundarban Biodiversity area—Patharpratima and Kultali in South 24 Parganas, and Hingalganj and Sandeshkhali-I in North 24 Parganas—using high-sensitivity data collection methods, revealed that continuous exposure to natural disasters, poor education, inadequate infrastructure, weak social structures, and limited transport facilities across isolated islands are critical barriers to socio-economic progress. The findings underscore an urgent need for sustainable management practices and alternative livelihood options. Suggested measures include mangrove forest restoration, provision of advanced fishing technology, better equipment, and promotion of livelihood diversification beyond fisheries. These strategies can strengthen resilience, improve living standards, and ensure long-term socio-economic security for Sundarban fishing communities.

Keywords: climate change; socio-economic status; fisherman; mangrove; Sundarban

Predicting the Impact of Missense Mutations of Enhancer of Zeste Homolog 2 (EZH2) Subunit of Ploycomb Repressor Complex 2 and its Relationship to the Tumor Microenvironment.

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ABSTRACT

Polycomb Group (PcG) proteins are epigenetic regulators and play crucial roles in the transcription of developmental genes for processes such as differentiation, stem cell plasticity or cell cycle progression. Mutations or dysregulations of PcG proteins have been extensively described in multiple cancers. PcG proteins were found to modulate the metabolic pathways and the immune responses in the tumor microenvironment. In mammals, two major PcG complexes, namely Polycomb Repressive Complexes 1 (PRC1) and 2 (PRC2), have been described. In human, PRC2 consists of four core subunits: (i) Enhancer of zeste homolog 2 (EZH2), (ii) Embryonic Ectoderm Development (EED), (iii) Suppressor of Zeste 12 (SUZ12), and (iv) Retinoblastoma suppressor Associated Protein 46/48 (RbAp46/48) and several auxiliary subunits. EZH2 is the enzymatic subunit of PRC2. The 751-amino-acid EZH2 protein has six domains: a WD-40 binding domain (WDB), domains I–II, two SWI3-ADA2-N-CoR-TFIIIB (SANT) domains, a cysteine-rich CXC domain and the evolutionarily conserved carboxy-terminal Su(var) 3–9-enhancer of zeste-trithorax (SET) methyltransferase domain. We have studied the role EZH2 in the tumor development and tumor microenvironment. We have identified several damaging and deleterious missense variants in human EZH2. We found pan-cancer wise expression of EZH2 was elevated in several cancers.

Keywords: Missense variants; Cancer; Epigenetic regulation; Tumorigenesis.

Biology and Management of Rice Grain Moth, *Sitotroga cerealella* (Olivier)

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ABSTRACT

The population explosion is creating an unprecedented demand for food worldwide. In India, postharvest losses caused by unscientific storage and pest infestations account for about 10% of the total food grains produced. Rice grain moth, *Sitotroga cerealella* (Olivier) (Lepidoptera: Gelechiidae), is a serious primary feeder and a cosmopolitan pest of stored cereals. Females lay eggs singly or in clusters on or near the grains. The eggs are white but change to a deep pink colour, with an oval shape and longitudinal ridges. The newly hatched larvae are pinkish or yellowish white and gradually attain a whiter colour. The pupa is brown. The adult moth is small, slender and pale yellow. Males are shorter than females. Adult females are larger than adult males. Many abiotic and biotic factors, like the quality and quantity of food, influence insect biology. Primary metabolites are slightly higher in rice than in maize and significantly lower in wheat, while secondary metabolites follow the reverse order. Therefore, the overall rate of growth, survival and fecundity of *S. cerealella* are highest in rice, followed by maize and wheat. Unfortunately, management of *S. cerealella* still relies on chemical pesticides, which have detrimental effects on the environment and human health. Therefore, population dynamics, nutritional ecology and economic threshold-based time-specific sustainable management are indispensable for this pest.

Keywords: Population dynamics; Nutritional ecology; Sustainable management.

Assessment of Mosquito Larvicidal Activity of Copper Nanoparticles Coated with *Grangea maderaspatana* Flower Extracts against Dengue Vector *Aedes aegypti*

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ABSTRACT

Mosquito, the notorious insect transmits various deadly diseases along the tropical realms of the world. Among these *Aedes aegypti* transmits dengue, yellow fever, zika, chikungunya etc. Previously, chemical pesticides were used for their eradication, but those being hazardous claimed the need of botanicals. In this study, copper nanoparticles coated with the flower extracts from *Grangea maderaspatana* showed effective mosquito larvicidal potential against *Ae. aegypti* larvae. According to WHO, larval mortality was determined against four larval instars of *Ae. aegypti* using the graded concentrations of both crude flower extract (0.5-0.9%) and phyto-coated CuNPs (5-25 ppm) for 24, 48 and 72 hours of exposure. Using regression and log-probit analyses LC_{50} and LC_{90} values were determined. *Chironomus* larvae were treated as non-target organism. Cent percent mortality was observed at 0.8% concentration of crude extract and 20 ppm concentration of CuNPs against all the larval instars. Phytochemical analysis of the crude extract revealed the presence of terpenoids, alkaloids, flavonoids and coumarin. Fourier transform infrared analysis confirmed the presence of alcohol, amine, alkane, carboxylic acids, ethers and ester as functional groups. Characterization of the phyto-coated CuNPs were done by UV-Vis, XRD, TEM, SEM and EDAX analyses. No adverse effect was found against the non-target organism. Thus, the CuNPs coated with flower extractives from *G. maderaspatana* can be used as potential larvicidal agent against *Ae. aegypti*.

Keywords: Grangea maderaspatana; Aedes aegypti; Copper Nanoparticles.

Biogenic Silver Nanoparticles for Jute Pest Control: A Green Leap in Agro-Nanotechnology

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ABSTRACT

Jute (*Corchorus* sp.), also known as "The golden fiber of India," is an essential cash crop farmed in Eastern India and is vulnerable to numerous insect pest attacks. Among them, *Spilosoma obliqua* is thought to be the most common jute pest in West Bengal. One of the most environmentally friendly methods of getting control of these jute pests is to apply nano-biopesticides, which are an efficient alternative to the dangerous chemicals. This study proposes a nano-biopesticide formulation that uses *Ocimum sanctum* leaf extract to produce green synthesized silver nanoparticles (AgNPs). The synthesis and characterization analyses utilizing UV-Vis spectroscopy, FTIR, XRD, TEM, DLS-ZETA, and SEM analyses confirmed the significant interactions between the AgNPs and the bioactive components in the nano-biopesticide formulation. Bioassays revealed that the nano-biopesticide had higher larvicidal activity than crude leaf extract. The pure extract and nano-biopesticide formulation showed significantly decreased LC_{50} values after 24, 48, and 72 hours of treatment. Compared to the crude leaf extract, which had LC_{50} values of 1590.74 ppm, 459.30 ppm, and 102.68 ppm, respectively, the nano-biopesticide formulation showed the lowest and most promising LC_{50} values of 93.21 ppm, 23.38 ppm, and 5.96 ppm. These results demonstrate the potential of silver nanoparticles anchored to *Ocimum sanctum* as an environmentally friendly substitute to biopesticide in the efficient control of jute pests.

Keywords: Nano-biopesticide; Jute; *Ocimum sanctum*; Sustainable Pest Management.

Last 2 Years Prevalence of Antimicrobial Resistance in Case of Urinary Tract Infection in India: A Pubmed Database Search Analysis of Case Reports

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ABSTRACT

Urinary Tract Infection (UTI) is a common disease in rural India. Patients take prescription less antibiotics. Due to lack of infrastructure, many rural laboratories also don't have the urine culture facilities. We have searched three words Urinary Tract Infection, Drug Resistance and Antimicrobial Resistance. year limit is 2023 to 2025. Also, we have taken case report and case series only. We only included Indian studies. We have found total of 8 case reports/ case Series. A total of 12 patients are present. 75% are male and 25% are female with a mean age of 50.58 and median of 50. 58% of patients have chronic and geriatric diseases. 25% of patients have acute diseases like road traffic accidents, post-partum hemorrhage and nephrolithiasis. 2 patients are post-kidney transplant patients. All the patients are admitted to the hospital with a urinary catheter. 92% of causative agents are gram negative bacteria like *Providencia rettgeri, Myroides,* Chryseobacterium, *Klebsiella Sp., S. marcescens, V. fluvialis.* Gram positive bacterias are M. lylae and M. luteus. 33% of cases are Pan-drug resistance, 58% of cases are extensively drug resistance and 9% are multi drug resistant. Post transplant patients are highly susceptible to pan-drug resistance Klebsiella infection It is important to take good care of chronically ill patients. Antibiotics should be taken after the urine culture reports.

Keywords: AMR; UTI; Rural India; Urine Culture.

Amelioration of Cisplatin-Induced Hematotoxicity in Swiss Albino Mice by Naphthalimide-Based Organoselenium Compound 2-(5-selenocyanatopentyl)-benzo[de]isoquinoline 1,3-dione

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ABSTRACT

Cisplatin is a well-known anti-cancer drug, used to treat broad spectrum of malignancies. But its use is often restricted due wide range of toxicities. Among various toxicities imparted by cisplatin, hematotoxicity is a very important one. Because of such toxicities, patient's quality of life is greatly reduced which in turn decreases the effectiveness of drug. Selenium, a dietary micronutrient, has been found to protect various organs from cisplatin induced injuries. This study was developed to explore the protective efficacy of an organoselenium compound 2-(5-selenocyanato-pentyl)-benzo[de]isoquinoline 1,3-dione against cisplatin - induced hematotoxicity in Swiss albino mice. Cisplatin (5 mg/kg b.w.) was administered intraperitoneally for 5 days and the organoselenium compound (3 mg/kg b.w.) was given by oral gavage in concomitant and pretreatment schedules. Various hematological parameters along with micronucleus assay from bone marrow were evaluated to assess the effect of the test compound. The oral LD50 of the test compound was more than 1000 mg/kg b.w. in Swiss albino mice. The test compound substantially prevented cisplatin-induced hematotoxicity by increasing the blood hemoglobin level, thymic cell count, spleen cell count, bone marrow cell count, total count of RBC and normalizing the differential count of WBC. In addition, the organoselenium compound was found to decrease the micronucleus count in bone marrow cells. The test compound emerged as an efficient agent protecting the experimental animals from cisplatin-induced hematotoxicity.

Disarming Cholera: *Typhonium trilobatum* Suppresses Toxins and Biofilms in Drug-Resistant *Vibrio cholerae*

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ABSTRACT

Cholera is a life-threatening epidemic disease caused by toxigenic strains of *Vibrio cholerae* belonging to the O1 and O139 serogroups. The growing antibiotic resistance in *V. cholerae* poses a serious public health threat. In this context, natural products like *Typhonium trilobatum* (L.) Schott, traditionally used in India for gastrointestinal disorders, may offer valuable alternatives. This study evaluated the antibacterial and antibiofilm activities of methanol extract of *T. trilobatum* leaves (METTL) against multi-drug resistant (MDR) strains of *V. cholerae* (O1, O139, non-O1, non-O139). MIC, MBC, and time-kill assays demonstrated antibacterial effects with MICs and MBCs ranging from 1–32 mg/mL and 8–32 mg/mL, respectively. METTL significantly ($P < 0.05$) inhibited biofilm formation in *V. cholerae* SG24 by up to 81.3%, and reduced extracellular polymeric substances by 89.41% (protein) and 99.26% (carbohydrate). Cholera toxin (CT) production was suppressed by 76.26% at MIC, and ctxAB expression was downregulated 1.76-fold at ¼ MIC. Key toxin regulators *toxT* and *tcpP* were significantly repressed, along with biofilm-associated genes (*vpsR*, *Bap1*, *rmbA*, *vpsT*). These findings highlight METTL as a promising candidate for developing novel antimicrobial and anti-virulence agents against MDR *V. cholerae*, while validating its traditional use. Future research should aim to isolate and characterize the active phytocompounds responsible for these effects.

Keywords: *Typhonium trilobatum*; Multidrug-resistant *Vibrio cholerae*; Antibiofilm activity; Cholera toxin inhibition.

Polymer Fingerprinting of Microplastics in the Indian Sundarbans Mangrove Ecosystem: First ATR-FTIR Spectroscopic Evidence of Riverine Microplastics from Three High Tourist-Load Zones

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ABSTRACT

The Sundarbans, world's largest tidal halophytic mangrove ecosystem, is facing increasing ecological stress from anthropogenic plastic pollution. Despite its global ecological significance, baseline data on microplastic (MP) contamination in its riverine systems remain sparse. This study presents the first comprehensive detection and characterization of MPs in surface waters from three high tourist-traffic zones named Godkhali, Dobanki, and Netidhopani. Using ATR-FTIR spectroscopy, synthetic polymers were detected along with their highest recorded concentrations and corresponding sampling stations, including nylon (44.80% at Netidhopani), polystyrene (24.39% at Dobanki), polyvinyl chloride (12.58% at Godkhali), followed by polyethylene terephthalate, polypropylene and polyethersulfone, which were present in lower proportions across the sites. Based on these observations, probable MP sources include upstream plastic inflow via rivers such as Hooghly and estuarine channels like the Gosaba, Thakuran, and Raimangal. Additional point sources comprise tourism-related waste (e.g., PET bottles, packaging), discarded fishing gear, synthetic ropes, and vessel coatings. This study uniquely integrates polymer-specific data with seasonal variation in water quality parameters, revealing both the scale and complexity of MP pollution in an ecologically fragile, estuarine zone. The findings call for urgent mitigation strategies, including sustainable tourism practices, continuous monitoring, and robust waste management to safeguard biodiversity and ecosystem health in the Sundarbans. Future efforts should prioritize exploring microbiome-assisted bioremediation techniques to reduce existing pollution and support ecological restoration.

Keywords: Microplastic; Sundarbans Mangrove Ecosystem; Polymer Characterization; Tourism.

Polymorphic influence of rs16969968 on CHRNA5 gene expression in COPD.

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ABSTRACT

Chronic Obstructive Pulmonary Disease (COPD) is a complex respiratory disorder, marked by progressive airflow limitation, emphysema, and chronic cough. Recent genome-wide association studies (GWAS) have identified a significant association between a single nucleotide polymorphism (SNP) rs16969968 in the of the nicotinic acetylcholine receptor subunit α5 (CHRNA5) gene and increased susceptibility to COPD. This study investigates the functional role of this variant in the West Bengal population, India. A total of 412 clinically diagnosed COPD patients and 390 controls aged between 40-80 years were recruited for the study. Participants were stratified into smoker and non-smoker groups. Lung function was assessed via spirometry (FEV1, FVC, FEV1/FVC, PEFR). Genotyping and allelic frequencies of rs16969968 were determined via PCR-RFLP method. In-silico analysis was by performed by FATHMM-XF, Mutation Assessor, PANTHER, I-Mutant 3.0. Gene expression of *CHRNA5* was quantified using qRT-PCR and protein levels were assessed through Western blot analysis. The rs16969968 AA genotype was significantly more prevalent in COPD patients ($P = 0.004$). Among smokers, AA carriers showed lower FEV1 and FEV1/FVC ratios ($P < 0.0001$). CHRNA5 mRNA and protein expression were significantly reduced in AA and AG genotypes compared to GG ($P < 0.0001$ and $P = 0.0001$, respectively). This first report from the West Bengal population suggests that CHRNA5 rs16969968 may be a functional genetic marker for COPD susceptibility, particularly in smokers.

Keywords: COPD; SNP; FEV1; Gene expression.

Zooplankton Diversity and Seasonal Variation in Relation to Physicochemical Changes in the Hooghly River.

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ABSTRACT

Zooplanktons are heterotrophic aquatic organisms that are cosmopolitan and act as bio-indicators. A regular successive sampling survey was conducted in three stretches of the Hooghly River to monitor the zooplankton diversity and their abundance for 6-7 months, and also to assess the impact of various physicochemical parameters on it. Four groups of Zooplankton were found, of which eighteen species of Copepoda, eighteen species of Cladocera, three species of Ostracoda, and nine species of Rotifera have been identified. Copepoda was the predominant group (65.8%), followed by Cladocera (14.0%). Species diversity and richness were generally higher in winter than in summer. Highest evenness and dominance were also observed at Site III. The study revealed the dominance of certain species, such as *Keratella sp*., *Moina sp*., *Daphnia sp*., and *Brachionus sp.* are considered to be the effective biological indicators for eutrophication. Various physicochemical parameters like dissolved oxygen, pH, BOD, etc., were recorded throughout the study period and have a strong influence on plankton diversity and abundance. In a temporal study, it was observed that Rotifers are dominant alongside copepods in winter, Ostracods and Cladocerans never dominate but contribute moderately to species composition. Our results showed that physicochemical changes influenced zooplankton composition and seasonal dominance in the Hooghly River.

Keywords: Zooplankton; Species richness; Physicochemical factors; Seasonal variation.

Cytogenetic and Apoptotic Impact of Synedrella nodiflora Aqueous Extract on Allium cepa Root Meristem: A Botanical Insight into Chemotherapeutic Potentials

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ABSTRACT

The present study explores the genotoxic and cytotoxic influence of aqueous extract from the aerial parts of *Synedrella nodiflora* (AAESN) using *Allium cepa* root apical meristem as a test system. Onion bulbs were exposed to graded concentrations (0.5–4 mg/mL) of the extract over different time durations (4–24 h). Cytological analysis revealed a significant dose-dependent decline in mitotic index, with frequent occurrences of chromosomal stickiness, c-metaphase, chromatin fragmentation, and aberrant mitotic structures. Apoptotic patterns were further verified by acridine orange–ethidium bromide fluorescence staining, indicating enhanced apoptotic and necrotic cell populations. The highest genotoxic and apoptotic indices were recorded at 2 mg/mL concentration after 24 h. The findings suggest that AAESN disrupts microtubule dynamics, causes metaphase arrest, and triggers programmed cell death, possibly via mitotic catastrophe. The results point toward potential chemotherapeutic applications of AAESN, warranting further molecular investigations. Overall, this botanical bioassay reinforces *Allium cepa* as a powerful screening tool for evaluating plant-based cytotoxic agents.

Keywords: *Synedrella nodiflora*; *Allium cepa*; Genotoxicity; Apoptosis.

Screening of potential cytotoxic activity of *Ampelocissus latifolia* (Roxb.) Planch.

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ABSTRACT

Phytochemicals from plant extracts have demonstrated excellent cytotoxic activities. Plants of different origins exhibit diverse bioactive chemical compositions. So, the discovery of phytochemicals from different parts of the world is always challenging. In this study, hydro-methanolic extracts of *Ampelocissus latifolia* (Roxb.) Planch. has been tested on *Allium cepa* root apical meristem cells. Here, the roots of *A. cepa* were treated with the hydro-methanolic extract of *Ampelocissus latifolia* (HMEAL) and compared to the control group. The extract-induced cell cycle delay and chromosomal aberrations were analysed. Results indicated a statistically significant ($p<0.001$) inhibition of root growth, a decrease in the mitotic index in the treated cells in a concentration dependent manner, and induction of different chromosomal abnormalities in the treated cells. Thus, the results demonstrated potential cytotoxicity of hydro-methanolic extract of *Ampelocissus latifolia* on *Allium cepa* root apical meristem cells.

Keywords: *Alium cepa*; Chromosomal abnormalities; Hydro-methanolic, Mitotic index.

Nanodiamond-Conjugated Harmine: A Promising Nanoformulation for Enhanced Anticancer Efficacy Against Liver Cancer Cells

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ABSTRACT

Hepatocellular carcinoma (HCC) is a leading cause of cancer mortality worldwide, demanding novel therapeutic approaches with improved selectivity and efficacy. Harmine, a β-carboline alkaloid, possesses notable anticancer potential but suffers from poor solubility and bioavailability. In this study, we report a novel nanodiamond-conjugated harmine (DND-HAR) formulation to enhance therapeutic efficacy against hepatocellular carcinoma. The nanoformulation was synthesized via optimized conjugation protocols and confirmed through UV-Vis and fluorescence spectroscopy, dynamic light scattering (DLS), zeta potential analysis, drug loading capacity, *in vitro* drug release profiling and ultrastructural validation using transmission electron microscopy (TEM) and energy-dispersive X-ray spectroscopy (EDX). DND-HAR displayed enhanced cellular uptake and potent anticancer activity against HepG2 and Hep3B cell lines. MTT assays revealed significantly lower IC_{50} values for DND-HAR compared to free harmine, with greater sensitivity observed in Hep3B cells. DAPI staining and DNA ladder assays confirmed nuclear fragmentation and apoptosis. ROS generation (DCFDA assay) and cell cycle arrest further validated its pro-apoptotic mechanism. Anti-metastatic properties were demonstrated via scratch wound healing and colony formation assays. Notably, 3D spheroid models reinforced its growth-inhibitory potential in a more tumor-relevant environment. Biocompatibility tests confirmed minimal cytotoxicity of DNDs in normal cells. Our findings highlight DND-HAR as a promising nanotherapeutic candidate for liver cancer, with improved efficacy, stability and enhanced apoptosis induction. This platform may contribute significantly to future HCC treatment strategies.

Keywords: Nanodiamond; Harmine; Hepatocellular carcinoma; Apoptosis.

Assessment of the Biofilm-Forming Capacity in a PGPR strain, *Bacillus subtilis* J-35, Under Metal and Pesticide Stress: A Functional and Molecular Comparison with Model PGPR *Bacillus subtilis* 3610

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ABSTRACT

Soil contamination with heavy metals and pesticides has emerged as a significant environmental concern, particularly in drought-prone regions where reduced rainfall further exacerbates the accumulation and toxicity of these pollutants. Biofilm formation ability in plant growth-promoting bacteria (PGPBs) has been identified as a key adaptive strategy that could enhance microbial survival in such hostile environments. Therefore, biofilm-forming PGPBs are projected to induce significantly enhanced seed protection and plant growth promotion in drought-prone and contaminated agroecosystems. In the present study, biofilm-forming capability of *Bacillus subtilis* J-35, a PGPB strain isolated from the rhizosphere of arid legume *Cyamopsis tetragonoloba*, was assessed using standard, morphological, biochemical, electron microscopic, and molecular approaches. The biofilm formation capability of strain J-35 was also assessed under heavy metal ($FeCl_3$, $CoCl_2$, $ZnCl_2$) and pesticide (malathion) stress. Results from this study showed that *B. subtilis* strain J-35 has robust biofilm production in the presence of multiple metal ions and malathion. Noticeably, strain J-35 significantly outperformed the model strain *Bacillus subtilis* 3610 in biofilm biomass. Also, genes associated with biofilm formation (*tasA*, *sinR,* and *bslA)* were also identified in strain J-35, thus validating the genetic basis of the robust biofilm architecture. Further assessment of this strain for plant growth promotion under heavy metal-contamination, pesticide contamination stress, along with drought, will underscore the dual utility of biofilm-forming PGPR in actively and sustainably remediating the contaminated and drought-degraded soils.

Keywords: Plant growth-promoting bacteria; Biofilm; Heavy metal contamination; Sustainable remediation.

Analysis of Aquatic Macrofloral Diversity from Three Study Areas of the East Kolkata Wetland, West Bengal, India

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ABSTRACT

East Kolkata Wetland, a Ramsar Site in West Bengal, has rich floristic diversity and plays a vital role in eco-restoration, environmental protection, and pollution control. It extends over 12,500 hectares, containing 37 mouzas. The present survey was conducted on the wetlands of three mouzas of the East Kolkata Wetland (Nonadanga, Chalk Kalarkhal and Patuli) from January 2023 to January 2025. The study has resulted in the documentation of 51 species of aquatic macrophytes belonging to 49 species of angiosperms and 2 species of pteridophytes from 41 genera and 27 families.

Alternanthera philoxeroides is found to be the most widely distributed plant throughout the all mouzas due to the highest mean frequency. The highest density and abundance are found in Lemnaceae. Aquatic macrophyte diversity shows significant positive correlation with frequency, density and abundance, where density exhibits the highest correlation with plant diversity. The survey has documented the highest plant diversity from Patuli during the winter season and the lowest diversity from Nonadanga during the summer. Statistical analysis reveals that aquatic macrophyte diversity does not significantly differ throughout the different mouzas or seasons.

This survey will be helpful to explore the aquatic macrophyte diversity and floristic composition of each mouza of the East Kolkata Wetland, which has remained untouched in all previous studies.

Keywords: East Kolkata Wetland; Aquatic macrophytes; Diversity.

Phytochemicals as Therapeutic Agents in Treatment of Hepatocellular Carcinoma: Prevention and Treatment

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ABSTRACT

Hepatocellular Carcinoma (HCC), the most prevalent type of primary Liver cancer, is a fatal global condition that affects millions of people worldwide due to its late diagnosis. Oxidative stress, abnormal cell growth, and avoidance of apoptosis play a central role in carcinogenic growth in Hepatocytes. Although chemotherapeutic agents are an extensive approach for cancer treatment, they often come with huge expenses and a lot of side effects for the patients. So, they have frequently been deterred from resorting to chemotherapeutic measures. Many natural products, which are phytoactive constituents derived from fruits, vegetables, nuts, and spices, are notable for their ability to combat malignant cells. It has been observed that the applications of phytochemicals in HCC are safer than the traditional chemotherapeutic treatment and also a very cost-effective one. This article explores the anticancer mechanisms of major phytochemicals, including flavonoids and alkaloids, for their contributions in modulating the signalling pathway, effects on cell cycle arrest, and induction of apoptosis. The effects of phytochemicals in combination with existing drugs, as well as the anticancer activities and the additive effects of phytochemicals, are also addressed here. The evidence of the significant reduction of the chances of this fatal disease with the consumption of a large amount of phytochemicals through fruits and vegetables are also investigated here.

Keywords: Hepatocellular Carcinoma; Apoptosis; Phytochemical; Angiogenesis.

Tulsi in Tradition and Therapy: A case study from Rural Muzaffarpur, Bihar

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ABSTRACT

Holy Basil, or Tulsi, is classified as *Ocimum tenuiflorum* and is culturally important in the ethnomedicine and spiritual life of people in Muzaffarpur, Bihar. This study records the traditional knowledge of Tulsi and its use through the interviews conducted with local healers, old aged people, and caregivers in the families. Holy Basil is part of folk medicine, especially in the treatment of common respiratory infections, fevers, digestive issues, and skin disorders. There are various folk preparations like decoctions, infusions, and pastes, which are usually prepared from the fresh leaves. Besides its veneration in daily and household prayer rituals, Tulsi is acclaimed in medicine, which is well documented, as is its pharmacological efficacy due to its constituents eugenol, ursolic acid, and rosmarinic acid. The blend of traditional medicine, local practices and scientific studies reveals local knowledge should be safeguarded. This paper underscores the importance of ethno-biomedical research in rural healthcare and advocates for active participation in the safeguarding of ethnobiological resources and the community-based conservation of the Muzaffarpur region.

Keywords: Tulsi, Lamiaceae, Ethnomedicine, Traditional Knowledge.

Genome-wide identification and characterization of Annexin family in Cowpea (*Vigna unguiculata* (L.) Walp.)

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ABSTRACT

Annexins are ubiquitous, evolutionarily conserved and multigene family of Ca^{2+}-dependent phospholipid and cytoskeleton binding proteins. By the process of Ca^{2+}-mediated signaling, they are involved in growth and development of plants and various kinds of biotic and abiotic stress responses. Although annexin genes have been identified in a number of plant species, but the information about annexin genes in cowpea was still missing. Our current study aimed to determine the possible role of annexins in cowpeas (*Vigna unguiculata* (L.) Walp.) by performing genome-wide identification and expression analysis. Fourteen annexin protein sequences have been identified in the cowpea genome. According to the functional motif analysis, fourteen VuAnn protein sequences possessed ten to seventeen motifs. Four to five introns were found in fourteen VuAnn members, according to the gene structure analysis. All the fourteen annexin genes were distributed on seven out of eleven chromosomes. The phylogenetic analysis revealed that the VuAnn members and annexins from rice, Medicago, and Arabidopsis were divided into four groups, i.e., groups I to IV. The majority of annexin promoters had cis-acting regulatory elements related to abiotic stress, growth and development, and phytohormone, suggesting the functional importance of annexin genes. Annexins are significantly expressed in a variety of tissues and developmental stages, according to expression studies, which indicates that they are essential for plant development. Overall, these results suggest that the annexin family potentially plays a role in abiotic stress responses and development in cowpea.

Keywords: Annexin; Cowpea; Expression; Promoter

In Vitro Regeneration and Genetic Assessment of *Picrorhiza scrophulariiflora* for Conservation Management

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ABSTRACT

Picrorhiza scrophulariiflora Pennell (Plantagianaceae) is one of the 814 threatened plant species in India and a valuable medicinal herb of the Indian Himalayan region. Despite its therapeutic significance, it faces severe threats from anthropogenic activities and ecological factors, yet no effective conservation measures have been reported. To determine its current population status, a vertical belt transects study revealed the species to be vulnerable in the Sikkim Himalayas. For mass propagation and conservation, efficient protocols for micropropagation, somatic embryogenesis, direct shoot regeneration from callus, and synthetic seed production were developed. Elite lines were identified using picroside I and picroside II as biochemical markers. HPLC analysis confirmed that the population from Ha, Bhutan had the highest total picroside content—7.33% (picroside I: 2.21%, picroside II: 5.12%)—and was selected as the elite line. Morphological and biochemical variation across populations was influenced by differences in soil properties and altitude, and correlation analysis was done to relate these factors to biomass yield. To determine whether variation in picroside content and biomass was due to environmental or genetic causes, RAPD marker-based genetic diversity analysis was conducted. The dendrogram grouped individuals into four sub-clusters based on geography, indicating that genetic factor, rather than environmental ones, are primarily responsible for variations in active biomolecule content in *P. scrophulariiflora*.

Keywords: Himalayan medicinal plant, *Picrorhiza scrophulariiflora,* Genetic diversity, Picroside content

Biocontrol potential of *Trichoderma* against rot disease causing pathogen of maize

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ABSTRACT

Rot disease of maize is one of the most serious diseases contributing a significant reduction in yield and quality of maize worldwide. In this study, causal organism of rot was isolated from the infected maize plant from the maize fields of Uttar Dinajpur, West Bengal and identified as *Fusarium moniliforme* (*F. verticilloides*). *Trichoderma asperellum* was employed against pathogen in vitro to assess its potential to control the pathogen. The efficacy of *Trichoderma asperellum* isolates (RGH1, RGD2, RGI1 and RGD3) for biocontrol was tested by their ability to produce chitinase, protease and siderophore. Antagonistic activity of the isolates against the *Fusarium moniliforme* was also recorded with highest percentage of inhibition of radial growth (40±1.54) by isolate RGD2. Additionally, all isolates of *Trichoderma asperellum* elicited the maximum production of defense enzymes, viz., PAL (phenylalanine ammonia-lyase) and PPO (polyphenol oxidase), in comparison to other treatments during the field experiment subsequent to the challenge inoculation of *F. moniliforme*. Thus, results revealed that *Trichoderma asperellum* being a potent biocontrol agent not only suppress the progression of pathogen but also induce the protection in plants against pathogen.

Keywords: *Fusarium moniliforme*; pathogen; *Trichoderma asperellum*; biocontrol agent.

Biochemical and Physiological Characterization of Indigenous *Rhizobium* Strains Isolated from *Phaseolus vulgaris* in Eastern Himalayan Regions

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ABSTRACT

French bean (*Phaseolus vulgaris* L.) forms symbiotic associations with various fast-growing *Rhizobium* species, including *R. leguminosarum* bv**.** *phaseoli***,** *R. tropici***,** *R. etli***,** *R. gallicum***,** and *R. giardinii***.** In the present investigation, eighteen *Rhizobium* strains—including the reference strain MTCC-99—were isolated from French bean root nodules collected from diverse locations across North Bengal and Sikkim. These isolates were subjected to biochemical characterization. All isolates demonstrated robust growth in yeast extract mannitol (YEM) medium at pH 7 and an incubation temperature of 30°C. They tested negative for ketolactase, gelatinase, cellulase, and catalase enzyme activities. However, when cultured on triple sugar iron agar medium (TSIAM), the isolates were confirmed as glucose fermenters. The strains exhibited varying degrees of tolerance to different sodium chloride concentrations. Notably, isolates such as DJG and SKM-N showed the ability to grow at low temperatures (10°C), while others tolerated temperatures as high as 40°C. Furthermore, all isolates (100%) grew successfully in dextrose medium. Carbohydrate utilization patterns revealed that most isolates formed clusters based on their geographical origin, indicating possible region-specific traits.

Keywords: *Phaseolus vulgaris*, *Rhizobium* spp., Biochemical characterization, North Bengal and Sikkim

Assessment of Impact of Seed priming on the Biofunctional Potential of Fenugreek Sprouts during early developmental phase

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ABSTRACT

The seed priming technique has been considered as an effective strategy to enhance therapeutic potential and stress tolerance in plants. The aim of the present study was to evaluate the effect of seed priming on biofunctional properties of *Trigonella foenum-graecum* (fenugreek) seedlings during early developmental phase. The fenugreek seeds were primed with calcium chloride an exogenous source of calcium ion and its antagonists namely, lanthanum chloride (LC) a calcium channel blocker and ethylene glycol-bis (2-aminoethylether) -N, N, N′, N tetra acetic acid (EG) a calcium chelator. Germination was conducted under controlled conditions in a seed germinator. The results revealed that sprouts pre-treated with priming agents exhibited enhanced antioxidant and antidiabetic properties over unprimed seeds; on the other hand, the effect was negatively impacted by the antagonists. When analyzing the effect of seed priming during time course of germination the stimulatory effect was most pronounced at the initial phase i.e. from 24 h to 48 h and then the action was declined during further extension of post-germination phases. This knowledge can be used to design the sprouting techniques which might have potential application in improving the nutraceutical quality of legume sprouts along with health relevant functional values.

Keywords: Biofunctional potential; fenugreek sprouts; germination; seed priming.

Documentation of Some Important Cooking Varieties of Banana, Bihar

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ABSTRACT

Banana is an important food crop which is packed with several nutrients. It is widely cultivated for both dessert and cooking purposes. Bihar is home to several indigenous varieties of banana. Traditional cooking varieties namely Batissa and Bhos of Bihar play an important role in local diets. It has been cultivated in Bihar for generations by local farmers. Due to dominance of commercial dessert varieties these varieties are underdocumented and underutilized. The present study aims to document and characterise these two important cooking banana varieties cultivated in the different districts of Bihar. Field surveys. discussion with the farmers were conducted and several morphological characteristics were observed. These varieties showed variations in plant height, pseudostem thickness, fruit apex, fruit shape and bunch appearance. Although, these varieties play an important role in culinary purposes yet the cultivation is declining. Therefore, proper documentation is needed for conserving these varieties. The findings highlight the importance of conserving these varieties for food security, agrobiodiversity and cultural preservation. Promoting these varieties will be beneficial for climate resilient agriculture in the region and recognition of indigenous knowledge.

Keywords: Documentation; bhos; battisa; agrobiodiversity; indigenous knowledge

Sacred Groves of the Lower Riverine Flood plains of West Bengal: A Traditional way of Nature Conservation

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ABSTRACT

Sacred groves are small patches of virgin forest preserved for centuries by indigenous communities through deep-rooted socio-cultural practices, religious beliefs and taboos. Despite their limited size, these groves serve as critical reservoirs of biodiversity, sustaining a wide variety of flora and fauna. In the Purba Medinipur district of West Bengal, the aboriginal communities have upheld a traditional culture of nature conservation, safeguarding these sacred forest fragments. These remnant groves are often the last remaining representations of ancient natural forests in the region. Their unique vegetational architecture creates diverse microhabitats, supporting rich gene pools and sustaining meta-community dynamics through a variety of ecological niches. In addition to ecological functions, the groves hold significant ethnobotanical value, especially as repositories of medicinal plants used in traditional healthcare. They also serve as refuges for endemic and threatened species. However, rising population pressure, coupled with expanding agricultural and industrial activities, poses a growing threat to the integrity of these ecosystems. The present study documents 20 sacred groves across varied ecosystems in the region. These groves support 57 major tree, 28 species of climbers and lianas, and 52 species of herbs and shrubs. Additionally, the study recorded 12 mammals, 13 bird, 11 reptiles, 3 amphibians, and 14 wild fish indicates high taxonomic diversity as well as biodiversity index which underscoring the ecological significance of these sacred groves. Now a days, sacred groves are vital conservation hotspots, meriting urgent attention and protection amidst growing anthropogenic pressures.

Keywords: Sacred Groves; Biodiversity; Traditional Conservation; Ethnobotany.

Microalgae as Natural Antioxidants: A Sustainable Source for Health and Nutraceutical Applications

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ABSTRACT

The demand for natural antioxidants is increasing day by day as compared to the artificial antioxidants as humans wish to intake nutritional supplements having no side effects. Microalgae is gaining importance as a sustainable and potent source of natural antioxidants with multiple applications in health as well as nutraceutical industry. They are unicellular photosynthetic microscopic organisms, with rich nutritional profile and potent bioactive compounds like vitamins, carotenoids, flavonoids, polyphenols, tocopherols, essential fatty acids etc which help in neutralizing free radicals and reducing oxidative stress in the biological systems. Hence presence of these constituents in microalgae contribute to play the role of strong antioxidants by scavenging reactive oxygen species (ROS) effectively and reducing oxidative stress, a major factor in pathogenesis of numerous chronic diseases such as heart diseases, cardiovascular diseases, oxidative damage, inflammation, and cancer. The introduction of antioxidants derived from microalgae into dietary supplements; functional foods is increasing as consumers wish to intake natural nutritional supplements which is beneficial to health and having no side effects like synthetic nutritional supplements. Moreover, the integration of microalgal antioxidants into nutraceuticals, foods, cosmetics industry holds a great promise for developing health and also supporting environmental sustainability. In this review paper the antioxidants compounds produced from different microalgae will be highlighted with their biochemical constitution, mode of action , health benefits, applications in nutraceutical industry.

Keywords: Microalgae; Nutraceutical; Antioxidants; Sustainable; Oxidative

Selection of Plants for Urban Green Belt Development and Phytoremediation Based on Response to Pollutant Stress

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ABSTRACT

Effects of pollution resulting from vehicular emission and soil contamination was studied on angiospermic and pteridophytic plants to assess their probable use in phytoremediation and green belt development. The angiospermic plants (*Cleome rutidosperma, Euphorbia hirta, Tabernaemontana divaricata, Ficus religiosa,* and *Mangifera indica)* were selected spanning different habits to analyse variation towards air pollution exposure. The pteridophytes (*Pteris vittata, Pteris multifida*) were selected for their ability to grow in dense masses requiring low maintenance. The anatomical and biochemical responses in relation to pollution stress were analysed. These data were used to calculate the Air Pollution Tolerance Index (APTI) to assess species-specific pollution tolerance levels for the angiosperms studied. The study found that plants from polluted environments show stress-induced alterations in their anatomical and biochemical features. These include reductions in chlorophyll and ascorbic acid content, acidic shifts in leaf pH, and structural distortions. *Cleome rutidosperma* and *Euphorbia hirta* show stress responses but maintain high APTI values, making them potential pollution-tolerant and bioindicator species. *Ficus religiosa* and *Mangifera indica* show strong tolerance and stable anatomical and biochemical traits, making them suitable for urban phytoremediation. Among the pteridophytes studied, results showed that *P. vittata* and *P. multifida* adopted anatomical characters. Plants showed variations in chlorophyll, total phenol, flavonoid content. Under different concentrations of arsenic stressor *P. multifida* shows marked biochemical variation in indicating its efficiency as hyperaccumulator of inorganic arsenic.

Keywords: Pollution-tolerant plants; Anatomical markers; Biochemical markers; Arsenic hyperaccumulators

Plant-Based Nanoparticles as Emerging Agents in Eco-Friendly Pest Management

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ABSTRACT

Plant-derieved nanoparticles represent a novel and eco-friendly approach to pest management in agriculture. These nanoparticles such as silver, zinc oxide, copper and iron oxide synthesized using various plant extracts, exhibit potent insecticidal, antifungal, antibacterial and repellent properties. Their biological origin ensures low environmental toxicity, biodegradability and reduced risk to non-target organisms, offering a sustainable alternative to conventional chemical pesticides. Numerous studies have demonstrated their efficacy against a wide range of agricultural pests and phytopathogens, with mechanisms including cellular disruption, oxidative stress induction, and enzymatic inhibition. Despite their potential, challenges such as standardization of synthesis protocols, comprehensive toxicity evaluations, and large-scale field applications remain. This review explores the synthesis, mechanisms of action, and recent advances in plant-based nanoparticle use for pest control, emphasizing their role in promoting sustainable and environmentally responsible agricultural practices.

Keywords: Nanoparticle; eco-friendly; pest management

Neurobiological and Temperamental Predictors of Criminal Propensity in College Students: A Narrative Review

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ABSTRACT

A special nexus of biological, psychological, and environmental factors can influence behavioural tendencies, including criminal propensity, during the transitional period of college life. This narrative review summarizes the most recent research on the neurobiological and temperamental elements that influence college students risk-taking behaviour and antisocial behaviour. Along with biological correlates like prefrontal cortex immaturity, amygdala hyperactivity, hormonal influences (like testosterone and cortisol), and neurotransmitter imbalances (like dopamine and serotonin), the focus is on temperamental traits like impulsivity, emotional reactivity, and sensation-seeking. The review additionally examines at how these individual factors work in combination with common college stressors like peer pressure, academic pressure, and substance exposure to make deviant behaviour more likely. Given that the prefrontal cortex continues to mature into the mid-twenties, gender differences and neurodevelopmental timelines receive particular attention. This paper offers a thorough understanding of biological risk profiles for criminal propensity in higher education settings by combining results from behavioural, psychophysiological, and neuroimaging studies. The results have implications for campus safety measures, mental health treatments, and early screening programs meant to stop deviant behaviour in this susceptible group.

Keywords: Criminal Propensity; Temperament; College Students; Impulsivity

Neural Influence Promotes the Aggressive Variant of Prostate Cancer

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ABSTRACT

In India, prostate cancer is becoming a growing concern for men below 50 years, who mostly presented with a lethal form of the disease during early presentation. Reports suggested that nerve influence can be a major factor for early development of aggressive prostate cancer. Anatomically, the prostate gland is surrounded by various nerve bundles, and pituitary hormones can influence the secretion of prostatic fluids. This is important for maintaining the normal physiology of the prostate gland. However, during the development of cancer, it often exhibits complex interactions with the peripheral nervous system, including increased nerve growth (axonogenesis), the creation of new neurons (neurogenesis), and direct signaling between nerve fibers and cancer cells. Specifically, sympathetic nerve fibers appear to play a major role in the early phases of tumor development, while parasympathetic fibers stimulate later stages such as invasion and metastasis. Therefore, this nerve infiltration favors perineural invasion, where prostate cancer cells and nerves engage in a bidirectional relationship that supports the growth and survival of cancer cells. These neuronal connections not only promote rapid tumor progression and metastasis but also promote tumor heterogeneity, which is difficult to treat with standard of care therapies. Therefore, early intervention and regular screening can manage the disease progression; however, the social stigma and utter ignorance make the situation ugly.

Keywords: Prostate cancer; Perineural invasion; Neural regulation; Early-onset malignancy

Hyperlipedemia and Probiotic Potential of Lactic acid Bacteria

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ABSTRACT

The presence of hyperlipidemia among people throughout the world has inflated and attained an epidemic level. Hyperlipidemia is a condition in which the plasma or serum contains elevated levels of total cholesterol (TC) and/or triglycerides (TG) and/or low-density lipoprotein (LDL); and low levels of high-density lipoprotein (HDL). Whatever be the causative factors of hyperlipidemia, long-term exposure to such a condition may be followed by various health issues like cardiovascular diseases, cerebrovascular diseases, atherosclerosis, metabolic syndrome etc. Although the use of drug therapy (statins, fibrate, etc.) has proved promising for the treatment of but are associated with various side effects such as diarrhea, abdominal discomfort, flatulence, dementia, low levels of vitamin D in the plasma, and sleep deprivation and are also very expensive. So much focus has been given to the ability of probiotics as an alternative strategy to curb the incidence of hyperlipidemia. In this study, the two lactic acid bacterial strains *Enterococcus durans* and *Enterococcus lactis* previously isolated from soft *chhurpi*, a traditionally fermented milk product prepared by the indigenous community of Sikkim Himalayas and healthy human gut were used. It is attempted to investigate the probiotic attributes, safety, and health beneficial role, and hypercholesterolemia of *Enterococcus durans* and *Enterococcus lactis* in SD rats. It gives new insight into the cholesterol-lowering and probiotic product development with wide health attributes.

Keywords: Hyperlipidemia; *Enterococcus*; drug therapy; probiotic

Detrimental Impacts of Flonicamid Exposure on a Non-Target Organism, *Drosophila melanogaster*

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ABSTRACT

Flonicamid is a systemic insecticide primarily employed to control sucking pests like aphids, whiteflies, and thrips. It works by disrupting the insects' feeding behavior, specifically by inhibiting their feeding, rather than through contact or stomach action. It has been know that, the pesticide is selective to its pests. However, environmental contamination of this pesticide raises concerns regarding possible exposure of non-targets to flonicamid. Hence, in the present study, effects of environmental concentrations of flonicamid on non-target insect, *Drosophila melanogaster*. Environmental concentrations such as 0.06, 0.1, and 0.14 ug/L have been selected for risk assessment analysis. Assessments for tissue damage, ROS generation and lipid peroxidation was carried out. Results have revealed dependent increase in tissue damage in alimentary tract of 3rd instar larvae of D. melanogaster. Further investigation revealed elevated ROS generation and lipid peroxidation in flonicamid-treated larvae compared to the control group. Hence, the findings of the present study suggest that flonicamid even at environmental concentrations can be detrimental to non-target organism, *D. melanogaster*.

Keywords: Flonicamid; *Drosophila melanogaster*; Pesticide; Oxidative stress

Lactic Acid Bacteria as Functional Biocultures for Antioxidant and Probiotic Applications

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ABSTRACT

Antioxidants play a fundamental role in protecting our body against oxidative stress that arises due to imbalance between the production of reactive oxygen species (ROS) and the body's ability to nullify or detoxify these harmful intermediates. The ROS includes superoxide anions, hydrogen peroxide, hydroxyl radicals, singlet oxygen etc. The excessive accumulation of ROS can cause oxidative damage to cellular structures thereby causing numerous health hazards and diseases in humans. Lactic acid bacteria (LAB) were isolated from traditional fermented food sources and preliminarily screened for DPPH free radical scavenging activity where 20 of the best isolates (78-60%) were further assessed for remaining antioxidant assays. All showed excellent antioxidant activities as demonstrated through FRAP assay, ABTS radical scavenging activity, Fe^{+2} ion chelating activity and resistance to hydroxyl and superoxide anion radical assay. Molecular identification of the isolates further revealed that *Limosilactobacillus fermentum* KL7, *Enterococcus faecium* KL20, *Enterococcus faecium* KL14 and *Enterococcus faecium* KL1 were strains of interest as they showed antioxidant activities ranging from 60-70% in aggregation. Along with antioxidant potential these strains also showed exceptional probiotic properties such as high tolerance to bile salts (67-97%), survivability in high acidic conditions (38%), higher cell surface hydrophobicity (56-60%) and auto aggregation capacities (75-83%). Hence the LAB strains stand as a promising candidate for recognition as functional biocultures for future applications.

Keywords: Lactic acid bacteria (LAB), antioxidants, probiotics, reactive oxygen species (ROS)

Evaluation of the probiotic potential and hypolipidemic efficacy of *Pediococcus pentosaceus* GWS5 using *in vitro* and *in vivo* approaches

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ABSTRACT

Hyperlipidemia, a chronic metabolic disorder, has posed a great threat to the human race, globally. Over the past, numerous researches have been devoted towards the formulation of safe, sustainable and cost-effective alternative to alleviate hyperlipidemia. Probiotics is one such alternative. This study aimed to evaluate the probiotic efficacy of *Pediococcus pentosaceus* GWS5, with emphasis on its hypolipidemic activity through *in vitro* and *in vivo* studies. The strain exhibited a cholesterol reduction percentage of 75.46% *in vitro*. The findings suggested that the strain qualified as a good probiotic since it was able to survive at pH 3, tolerate different bile concentrations, possessed bile salt hydrolase activity; and a good cell surface hydrophobicity and autoaggregation activity. Apart from being safe for use, it also exhibited a strong antagonistic activity against many foodborne pathogens. *In vivo* trials conducted on high-fat diet induced Wistar rats suggested that the strain significantly ($p<0.05$) reduced the serum cholesterol, triglycerides, low-density lipoprotein and very low-density lipoprotein levels to 18.57%, 27.18%, 26.77% and 27.16%, respectively. In contrast, the high-density lipoprotein level was significantly increased to 37.10%. Similarly, the antioxidant (reduced glutathione and catalase) levels in the probiotic supplemented rats increased in contrast to the model control group. Therefore, this study suggested that *Pediococcus pentosaceus* GWS5 might serve as a promising probiotic candidate with a potential role in ameliorating hyperlipidemia.

Keywords: Hyperlipidemia; Metabolic disorder; Probiotics; *Pediococcus*.

The Impact of Water Quality Parameters on Phytoplankton Distribution in Anicut Dam of Kangsabati River, PaschimMedinipur, West Bengal

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ABSTRACT

This investigation focuses on impact of environmental parameters on phytoplankton group at anicut Dam in the Paschim medinipur district. We identified six phytoplankton classes includes *Zygnematophyceae, Chlorophyceae*, *Bacillariophyceae*, *Ulvophyceae*, *Cyanophyceae*, and *Klebosormidiophyceae*. We observed 20 genera: 4 from *Zygnematophyceae*, 5 from *Bacillariophyceae*, 5 from *Chlorophyceae*, 4 from *Cyanophyceae*, 1 from *Ulvophyceae*, and 1 from *Klebsormidiophyceae*. *Zygnematophyceae* was the dominant group (46%), followed by Chlorophyceae (30%), Bacillariophyceae (17%), *Cyanophyceae* (3%), and *Ulvophyceae* (4%). We found that the highest Shannon-Wiener diversity index and evenness were observed in the post-monsoon season (1.58 and 0.81), while the lowest diversity and evenness were recorded in the pre-monsoon season (0.98 and 0.53). Additionally, dominance was highest during the pre-monsoon and lowest during the post-monsoon. Our research also transpired significant seasonal differences in the phytoplankton community composition ($P < 0.05$). Markedly, this type of research is valuable for the sustainable management of native fish populations in rivers and is crucial for communities that depend on fishing for their livelihoods.

Keywords: Canonical correspondence analysis (CCA); Diversity Index; Phytoplankton; Seasonal variation;

Seasonal Occurrence of Red Pumpkin Beetle (*Aulacophora foveicollis* Lucas) on Bottle Gourd (*Lagenaria siceraria*) and its Management

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ABSTRACT

A field experiment was conducted on bottle gourd (*Lagenaria siceraria*) crop at Changuria village, Mallickpur Gram Panchayet, Birbhum district of West Bengal during two-year 2022 and 2023 to study seasonal occurrence of pumpkin beetle on bottle guard and its management. Red pumpkin beetles (*Aulacophora foveicollis* Lucas) feed on leaves, flower, fruits, tendrils etc. and it is a serious insect pest of bottle gourd cultivation. The pest appeared (0.65 number of beetles/plant) in the field on 6th Standard Meteorological Week (SMW) that is 1st week of February and population increased rapidly. Higher population (10.20 – 13.30 number of beetles/plant) was recorded on 10th SMW - 13th SMW that is in the month of March. Highest population (13.30 number of beetles/plant) was recorded on 13th SMW that is 4th week of March. Pumpkin beetle population had a positive (+) correlation with maximum temperature (r = 0.436), minimum temperature (r = 0.383) and average temperature (r = 0.415). A negative (-) correlation was found between pumpkin beetle population and maximum relative humidity % (r = -0.368), minimum relative humidity % (r = -0.211), average relative humidity % (r = -0.327), total rainfall (r = -0.378). Cypermethrin 10% EC was found most effective insecticide (63.30 % reduction of pumpkin beetle population over control) for management of pumpkin beetle.

Keywords: Red pumpkin beetle, seasonal occurrence, correlation co-efficient, abiotic factors

Beyond Acidity: Advancements in Omeprazole's Effects on Physiology, Impact on Nervous System and Cognition

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ABSTRACT

Omeprazole, a substituted benzimidazole, inhibits proton pumps in gastric parietal cells and is widely used mainly for GERD and hypersecretory diseases. Prolonged administration of this drug, with or without the prescription of a certified medical practitioner, can have multiple severe physiological implications. Studies have shown how omeprazole can elevate neuropathy, cognitive disorders, dementia, and anxiety and decrease serotonin receptor expression, causing hippocampal synaptic dysfunction. Excessive and repeated usage of omeprazole can interfere with hepatic cytochrome P-450 enzymes and inhibit neutrophil function. This causes natural killer cell dysfunction, making innate immunity vulnerable to diseases like hepatitis and hypersensitivity. Omeprazole also disrupts bivalent ion levels like magnesium in the gut, slowing down vitamin B12 absorption. Also, it has a high risk of kidney damage, nephrotoxicity, and renal failure, along with some potential cases of cardiac ischemia and arrhythmia. Also, overuse of omeprazole may lead to reproductive and developmental toxicity in rats, with some potential effects and risks associated with faulty pregnancy. After seeing these multidimensional physiological problems, we tried to determine whether any plausible alternatives could be administered and whether these side effects could be minimised. We also tried to find if there are some significant changes in blood or different physiological parameters that we can detect early via cost-effective tests and visible signs to determine when to stop the drug toxicity.

Keywords: Omeprazole; Proton Pump Inhibitor; Nervous System; Physiology.

Identification of Flavonoid Present in Mango Pulp Extract

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ABSTRACT

Mango is a traditional household fruit. Mango pulp can be considered as a nutraceutical due to its rich content of vitamins, minerals and antioxidants which are responsible for preventing diseases, protecting our health. It contains polyphenols which will help to protect our body against oxidative stress and damage from free radicals. Among four types of polyphenols, present in plants, flavonoids are the most dominant class. These flavonoid compounds have cardioprotective, antioxidant, anti-inflammatory, anti-cancer and antimicrobial activities. In this study, the presence of flavonoid compound(s) has been qualitatively identified by different tests e.g. Shinoda test. Ferric chloride test etc. By using UV-Visible spectroscopic method, the presence of flavone compound (s) has been confirmed. Total flavonoid content has been estimated by using aluminium chloride method. With the help of shift reagents such as sodium hydroxide, sodium acetate, aluminium chloride**,** sodium nitrate etc, flavonoid chrysin has been identified. Chrysin, is a natural flavonoid, known for its antioxidant, anti-inflammatory, anti-cancer, and neuroprotective effects. Chrysin acts as an antioxidant by scavenging free radicals and reducing oxidative stress and hence forth, can protect our body against neurodegenerative diseases by reducing neuroinflammation, oxidative stress, and apoptosis. Antioxidant activity of chrysin has been elucidated by DFT study. Chrysin has shown anti-proliferative and pro-apoptotic effects in various cancer cell lines, potentially inhibiting cancer cell growth and metastasis.

Keywords: Flavonoids; chrysin; antioxidant assay; DFT study

Assessing the Alterations in Interactions of Graphene Quantum Dots with Oxy and Deoxy Myoglobin

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ABSTRACT

Hemeproteins such as myoglobin's role is primarily associated to binding molecular oxygen for proper functioning. Heme moiety responsible for oxygen binding remain incorporated in a hydrophobic cleft. Also, any ligand that interacts with hemeproteins is expected to involve heme. Keeping this in mind we have assessed the ligand binding ability of oxymyoglobin (oMB) and deoxy myoglobin (doMb) by molecular docking studies. The observations may indicate the alterations in structure and ligand interacting properties of myoglobin upon binding with oxygen. The ligand chosen here is an important member of carbon nanofamily- graphene quantum dot. As observed, the binding affinity in terms of docking score seems to be more for doMb compared to that of oMb. Apparently, oxygen binding of myoglobin decreases its affinity for other ligands. Not only that, the interacting residues and the corresponding binding pocket and the probable nature of interactions also appear to significantly differ for oMb and doMb. Thus, the study opens new insight for the drug-delivering ability of myoglobin and highlights the structural perspectives related to alteration in tertiary structure of myoglobin upon binding with nano-ligands of biomedical importance in presence of oxygen.

Keywords: Oxymyoglobin; Deoxy myoglobin; Graphene Quantum Dots; Molecular Docking.

Feigning Death to Survive: Ontogeny and Context-Dependent Anti-Predatory Behaviour in a Biocontrol Agent

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ABSTRACT

Invasive weeds pose significant threats to agriculture and biodiversity worldwide. Biological control agents, such as the Chrysomelid beetle *Zygogramma bicolorata*, have been used to manage the invasive weed *Parthenium hysterophorus*. The success of these agents depends not only on their feeding ability but also on their survival in the presence of predators. This study investigates tonic immobility (TI), a defensive behaviour where animals adopt a motionless posture when threatened, resembling dead individuals. Despite being widespread across the animal kingdom, TI and its ecological implications remain poorly understood. We provide the first report of TI in *Z. bicolorata*. Further, through a series of behavioural assays, we examined three aspects: (1) ontogenetic changes in TI across larval and adult stages to understand its developmental trajectory; (2) plasticity in TI expression to test how context shapes this defensive behaviour; and (3) predator-preference tests to assess the functional significance of TI in reducing predation risk. Our findings show that the expression of TI varies with the developmental stage, though the duration of TI in larvae and adults was not correlated. Predator-preference experiments indicate a potential anti-predatory role of this behaviour. We also found that TI trades off with other defensive behaviours, highlighting a plastic, adaptive strategy. These findings provide insights into the evolution of behavioural defences in biocontrol agents, enhancing their effectiveness in ecosystems.

Keywords: Tonic immobility, Thanatosis, Zygogramma bicolorata, Parthenium hysterophorus

Evaluation of the Activity of Gold Nanoparticles from Wheat Grass Extract Against Drug-Resistant Bacteria

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ABSTRACT

Gold nanoparticles (AuNPs) can be synthesized from plant extracts via environmentally friendly and economically more feasible green technology. The present study uses the phytochemicals present in the aqueous extract of wheat grass (Triticum aestivum) as the reducing and stabilizing agent. The production of AuNPs was investigated using UV-Vis spectroscopy, which showed a surface plasmon resonance at 540 nm. The functional groups owing to the polyphenols were analyzed by FT-IR. The SEM & TEM analysis revealed the presence of spherical AuNPs with a size range of 20-40 nm. The agar well diffusion method was used for the evaluation of the antibacterial potential of the wheat grass extract as well as of gold nanoparticles. Then, the zone diameter and minimum inhibitory concentration were noted. The green-synthesized AuNPs demonstrated strong antibacterial properties towards Gram-positive & Gram-negative bacterial species. This study validated the use of wheat grass extract for therapeutic purposes in herbal and traditional medicine. The findings also supported the ability of bioactive components in wheat grass as a capping agent for the formation of nanoparticles. Thus, using green nanotechnology, AuNPs can be formed from wheat grass extract, and these particles show good antibacterial activity, supporting their role as therapeutic agents. Additionally, the reduced cytotoxicity of gold nanoparticles greatly supports their use as alternative antimicrobial agents

Keywords: Wheat grass, antibacterial activity, Gold Nanoparticles, Green nanotechnology.

Health and Nutritional Status of Sedentary Workers in Puducherry: An Investigative Study

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ABSTRACT

This study aimed to assess the nutritional status and health profile of sedentary workers in Puducherry, India as the issues related to nutritional status and health is getting increased day by day. A purposive random sample of 30 participants, including teachers, administrative workers was selected from the Government Middle School from Puducherry region. Data were collected using a structured questionnaire covering socio-economic background, anthropometric measurements, dietary intake (via 24-hour recall), clinical symptoms, and physical activity patterns. Results revealed that 73.3% of the participants were obese, and a majority showed clinical symptoms such as fatigue (53.3%), cold intolerance (56.6%), dry hair (73.3%), and muscle pain (63.3%). While 60% reported engaging in some form of exercise, 40% were physically inactive. Dietary patterns showed high cereal, pulse, and vegetable consumption, but moderate intake of fruits and milk products. The findings suggest a significant correlation between sedentary lifestyle and risk of obesity-related health issues. The study concludes that nutritional awareness and regular physical activity are essential to mitigate health risks among sedentary workers.

Keywords: sedentary lifestyle, nutritional assessment, obesity, dietary habits, physical activity, health status, Puducherry

Reviving Triphala: Ayurveda's Answer to Antimicrobial Resistance

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ABSTRACT

Antimicrobial resistance (प्रतिजैविकप्रतिरोधः) is a pressing global health crisis, especially for hematogenous infections (रक्तदूषणम्). This study explores Triphala, a time-honored Ayurvedic blend of Āmalakī (*Phyllanthus emblica*), Bibhītakī (*Terminalia bellirica),* and Harītakī (*Terminalia chebula*), as a potent countermeasure against resistant microbes. Anchored in Sanskrit texts like Charaka Saṃhitā— "त्रिफला कषायानुरसा दीपनी बलवर्धिनी" (C.S. Sū. 4.12)—and Bhāvaprakāśa— "त्रिफला रक्तपित्तघ्नी च क्रिमिघ्नी च विशेषतः"—Triphala is lauded for its antimicrobial and rejuvenative (रसायणम्) qualities. Experimental results show Triphala's antimicrobial efficacy rivals Vancomycin at higher doses, while also boosting immunity (व्याधिक्षमतावर्धनम्). By promoting dhātu-sāmya (tissue balance), Triphala addresses both disease symptoms and underlying causes, offering a holistic alternative to conventional antibiotics. This research champions the fusion of Sanskritic medicinal wisdom with modern science, positioning Ayurveda as a sustainable, culturally grounded strategy to combat antimicrobial resistance. Triphala's dual therapeutic and preventive potential highlights its role in bridging ancient insights with contemporary health solutions.

Keywords: Triphala, Ayurveda, Antimicrobial Resistance, Immunity Boosting

Understanding Disease Dynamics Using Stochastic Models

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ABSTRACT

Stochastic models are ideal tools for studying living systems, which are inherently out of equilibrium in nature. In this project, we model the spread of COVID-19 using Cellular Automata within the Susceptible - Exposed - Infectious - Removed (SEIR) framework by considering the reinfection in the disease spread. Our model employs a probabilistic neighbourhood interaction, in which the transmission probability of the disease between cells is inversely proportional to the *n*th power of their distance. With this approach, we are able to reproduce some important features of the pandemic, which makes this model relevant for further studies. We also finally test our model accuracy and predictive ability against real COVID-19 data from a few countries. Currently, we are trying to understand how the Vicsek model can be effectively adapted to simulate spatial and movement-based disease dynamics, particularly in the context of COVID-19.

Keywords: Disease Spread; Cellular Automata; COVID-19; Vicsek Model

Associations of Vitamin D and VDR Genetic Variants with Cognitive and Motor Impairment in Parkinson's Disease

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ABSTRACT

Vitamin D (vit-D) exerts neuroprotective, immunomodulatory, and calcium-regulatory effects primarily via the vitamin D receptor (VDR), a nuclear transcription factor abundantly expressed in brain regions relevant in Parkinson's disease (PD). VDR gene polymorphisms—FokI (rs2228570), BsmI (rs1544410), ApaI (rs7975232), and TaqI (rs731236)—may alter receptor activity through changes in protein structure or mRNA stability, potentially influencing PD susceptibility and progression. In this study, 30 clinically diagnosed PD patients underwent genotyping for VDR polymorphisms using PCR-RFLP on DNA from buccal swabs. Serum vit-D levels were measured by ELISA. Human disease databases like GenCLip3 and Malacards were explored for gene-disease association. In-silico analysis identified VDR among top PD-associated genes. Hypovitaminosis D was observed in 66.66% of participants. Vit-D levels showed a positive correlation with cognitive performance (MoCA) and a negative correlation with motor severity (UPDRS III, Hoehn & Yahr scales). Significant associations were found between the VDR-BsmI polymorphism and MoCA scores ($p = 0.008$), and between VDR-ApaI and H&Y scale ($p = 0.007$), suggesting genotype-dependent modulation of PD symptoms. To the best of our knowledge, this is the first pilot study from India exploring the association of VDR polymorphisms with clinical outcomes in PD. These preliminary findings highlight the potential role of vit-D and VDR variants in PD-related cognitive and motor dysfunction, warranting larger multi-ethnic studies for validation and therapeutic exploration.

Keywords: Hypovitaminosis D; Parkinson's disease; Polymorphisms; Vitamin D receptor

Melamine Alters the Reproductive Functions of Ovary and Uterus in Rat

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ABSTRACT

Now a day's adulteration in food components is very common in food industry because of excessive production and preservation of food. Melamine is a food adulterant which has several industrial uses. There are various toxicological reports about the health effect of melamine. But there is a knowledge gap about the toxic effect of melamine on female reproductive system. The objective of the present study was to examine the probable toxic effect of melamine on female reproductive system functions in rat. Experiments were performed on female rats (Control and LD_{50} of 5% and 10% melamine exposed group for 28 day**)** of Charles Foster strain, by oral gavage. In our study, we observed significant changes in duration and cellular characteristics of estrus cycle. The contraction of uterine smooth muscle was increased significantly compared to contraction of uterine smooth muscle of control rats. We also observed the alterations of histological characteristics of ovary and uterus of melamine exposed groups of rat compared to control. From these results, it can be concluded that melamine impairs the function of ovary and uterus in female rat probably by altering the phases of estrous cycle physiology and uterine smooth muscle contraction probably by augmenting to secretion of oxytocin which induces the contraction of uterine smooth muscle and structural degeneration in wall structure of ovary and uterus.

Key words: Melamine; Ovary; Uterus; Estrous cycle; Female reproductive system

Unmasking the Invisible Threats: A Study on Occupational Exposure, Oxidative Stress, and DNA Damage in Traffic Police Personnel of West Bengal

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ABSTRACT

Traffic policing involves high unpredictability, prolonged environmental exposure, and chronic stress. In West Bengal, where ambient air quality often exceeds national standards, traffic police personnel are regularly exposed to respirable suspended particulate matter (RSPM), vehicular emissions, and toxic gases. This study investigates the occupational health risks faced by traffic personnel across various zones. Results show a significant decline in pulmonary function and increased incidence of respiratory, gastrointestinal, and cardiovascular disorders. Long-term exposure to pollutants such as carbon monoxide, sulfur and nitrogen oxides, and PAHs is a major contributing factor. To explore cellular-level effects, biomarkers of oxidative stress and genotoxicity were assessed. Elevated levels of reactive oxygen species (ROS) indicated oxidative damage, while DNA damage was confirmed through Comet assay and micronucleus tests. Psychosocial stressors—including administrative pressure, irregular shifts, and disrupted circadian rhythms—were associated with anxiety, fatigue, and depression. The COVID-19 lockdown further exacerbated sleep disturbances and biological rhythm disruption. This study highlights the urgent need for health surveillance, early intervention, and policy reforms to safeguard traffic police personnel from cumulative environmental and occupational stressors.

Keywords: Traffic Police Personnel; Air Pollution; Oxidative Stress; DNA Damage; Occupational Health; Lung Function; Sleep Disturbance

Prevalence of Cadmium Toxicity Consuming Crops from Industrial Regions in Metro Cities of India

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ABSTRACT

Cadmium (Cd) is a toxic, carcinogenic heavy metal that enters the human body primarily through dietary sources, particularly food grown in contaminated soils near industrial belts. Increasing industrial activity in and around Indian metro cities has raised serious concerns about the prevalence of high cadmium levels and the associated toxicity among urban residents consuming locally harvested produce. The expansion of industrial activity and use of phosphate fertilizers in India could have influenced cadmium exposure. Regional studies have reported occasional exceedance of WHO provisional tolerable weekly intake (PTWI) in certain areas due to contaminated irrigation water or industrial pollution. However, India lacks systematic, nationally representative time-series data on cadmium intake comparable to surveys conducted by other countries (such as Japan or Korea). Most Indian research provides only single-time-point measurements or localized case studies. Several findings reveal a worrying prevalence of high cadmium levels in metro city populations dependent on food harvested from India's industrial belts. This underscores the necessity for urgent public health interventions, including stringent monitoring of food sources, remediation of contaminated agricultural lands, and the establishment of regular biomonitoring programs to mitigate long-term health risks associated with cadmium toxicity.

Keywords: Cadmium toxicity; Metro cities; Food contamination; Public health.

Exploring the Mechanism of Action of *Varmam Therapy*, Therapeutic Technique of Tamil Nadu Analogous to Acupressure, in the Symptomatic Management of Knee Osteoarthritis

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ABSTRACT

Background: Recently drugless therapies are sought much for knee osteoarthritis. Varmam is one such cost effective, non-invasive therapy practiced in Traditional Siddha Medicine of Tamil Nadu, in which the physician manipulates certain vital body points to relieve pain.

Objectives: To find the probable mechanism of action of varmam therapy in reducing knee joint pain of knee osteoarthritis.

Methodology: An open, non-randomized, controlled trial was conducted with 45 patients each in treatment and control group. Trial group subjects received varmam therapy for 4 weeks followed by a 6-weeks follow-up. The control group participants were on their routine Siddha drugs. VAS score, WOMAC Index, Estimation of Erythrocyte Sedimentation Rate, C reactive protein and serum β endorphin were the outcome measures. All of these except endorphin were measured at baseline, 4^{th} and 10^{th} week. Serum endorphin was measured at baseline and 4^{th} week. All the data were analysed using Graph pad Prism statistical software.

Results: At 4th Week, VAS Score, WOMAC Functional and Total Score showed significant improvement in the treatment group. t - test value of serum beta endorphin showed significant increase from baseline level in the trial group at 4^{th} week [p value < 0.008]. However, ESR and CRP showed less changes.

Conclusion: Improvement in knee joint pain and consistency of response might be due to neuronal effect rather than anti-inflammatory activity. We need more such studies to clearly delineate the mechanism of action of varmam therapy.

Keywords: Osteoarthritis; Siddha; Varmam; Endorphin

Effect of Oral Intake of Monosodium Glutamate (MSG) on Body Weight and its Correlation to Stomach Histopathological Changes in Male Albino Rats

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ABSTRACT

Monosodium glutamate (MSG) is a worldwide food additive commonly used as a flavour enhancer. The safe use of MSG has generated much controversy regarding weight gain and health effects. In the present study, the effects of MSG administration on weight gain and on the structure of gastric mucosa in rats were investigated. Twelve adult male rats were used and randomly divided into two treated (A and B) and one control (C) groups (n=3, each). The rats of control group (C) received only standard diet with water, low dose test group (A) rats received 0.5 mg/Kg of MSG dissolved in distilled water and high dose test group (B) rats received 1.5 mg/Kg of MSG dissolved in distilled water per orally for a period of 28 days. Results revealed a steady increase in body weight and food consumption in the treated groups. The gastric mucosa of the rats treated with low dose showed a number of pathological alterations which were more pronounced in the group treated with high dose. These results indicate that prolonged administration of MSG causes an initial increase in weight gain. This may be explained by the induced gastric mucosal damage. In conclusion, it appears that although the consumption of MSG can be regarded as harmless, yet prolonged intake might induce gastric damage and alteration in overall body weight.

Keywords: MSG; albino rat; gastric mucosa; weight

Potential Health Risks of Pharmaceutical Contaminants in Ganga River Linked to Endocrine Disruption and Antibiotic Resistance

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ABSTRACT

The augmented prevalence of contaminants such as pharmaceutical products (PPs) and endocrine-disrupting compounds (EDCs) in surface waters has become an issue of global concern. The unchecked use of antibiotics in medical and agricultural fields has been documented to produce antibiotic resistance and endocrine disruption in aquatic animals as well as humans. These pharmacological agents have penetrated all aquatic niches including underground water, surface water and soil in quantities ranging from few nanograms to grams per litre. Thus, there is an urgent need to understand the potential health risks associated with these contaminants. This study emphasises on the impact of pharmaceutical pollutants, particularly the endocrine-disrupting compounds (EDCs) present in the surface water of Ganga River around Kolkata in West Bengal. Analysis of particular endocrine disrupting compounds (EDCs) present in Ganga, such as phthalic acid esters (PAEs) and bisphenol A (BPA), have been reported to exhibit estrogenic potential that could affect the reproductive cycles. Pharmaceutical pollutants that showed maximum ecological risk in water was found to be triclocarban followed by 17α-ethinylestradiol (EE2), 17β-estradiol, diclofenac, and atenolol originating from plastic additives in wastewater from industrial and domestic sources, run-off, atmospheric deposition and leaching from microplastics. Improper disposal of biowaste from medical sources pose a significant health risk that need to be controlled and mitigated or else could lead to far-reaching consequences.

Keywords: pharmaceutical products; endocrine disruption; antibiotic resistance; surface water contamination

Bipolar Disorder

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ABSTRACT

Bipolar disorder is a one of the mood disorders that is associated with considerable psychosocial and economic morbidity. It is characterized by impairing episodes of mania and depression which is more common than previously thought and somewhat neglected in terms of research when compared to disorders such as schizophrenia and major depression. The biological basis of bipolar disorder is unknown, and the treatment is unsatisfactory. Recent advances in the fields of epidemiology, digital technologies with sophisticated mathematical and computational analyses, stem cell pharmacotherapy and molecular genetics in particular have begun to unveil some of the complexity of this disorder and the next few years are likely to witness substantial changes to the ways in which the broad spectrum of bipolar disorders is diagnosed and managed.

Keywords: Bipolar disorder; depression; mania

Attention-Deficit Hyperactivity Disorder

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ABSTRACT

Attention-deficit hyperactivity disorder (ADHD) is a common neurodevelopmental illness affecting 8-12% of children worldwide characterized by inattention, impulsivity, and hyperactivity that have devastating long-term consequences if untreated. Although the condition was identified 100 years ago, it is only in the past decade that information has been clarified. Studies have shown that untreated individuals have worse outcomes than treated patients in academic, occupational, and social functioning antisocial behavior, substance use etc. Recognition and management of ADHD in children is important so that their long-term outcomes can be improved. Converging evidence from animal and human studies implicates the dysregulation of frontal-subcortical-cerebellar catecholaminergic circuits in the pathophysiology of ADHD, and molecular imaging studies suggest that abnormalities of the dopamine transporter lead to impaired neurotransmission. New medication is continually being developed and differential diagnosis should include the possibility of comorbid psychiatric disorders and other developmental disorders. Neuropsychological testing may be valuable for both diagnosis and the assessment of treatment response.

Keywords: ADHD, hyperactivity

Edible Insects for Sustainable Food Security

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ABSTRACT

With the global population projected to reach nearly 10 billion by 2050, ensuring sustainable and resilient food systems is more urgent than ever. Edible insects offer a promising solution to future food security challenges due to their high nutritional value, low environmental impact, and efficient **protein** conversion rates. Among them, grasshoppers, crickets, mealworms, and black soldier flies stand out for their rich content of essential amino acids, vitamins, and minerals. Grasshopper farming**,** in particular, is gaining traction for its scalability, fast reproduction, and adaptability to various climates. Insect farming requires significantly less land, water, and feed compared to traditional livestock and emits fewer greenhouse gases. Additionally, many insect species can be reared on organic waste, promoting circular agriculture and reducing food system waste. While cultural acceptance and regulatory frameworks remain challenges, technological advancements and growing awareness are accelerating the integration of edible insects into mainstream diets. This article highlights the potential of edible insects, especially grasshoppers, to contribute to global food sustainability and nutrition in an ecologically responsible way.

Keywords: Entomophagy; Grasshoppers; Food security; Protein; Sustainability

Bacterial Quorum Sensing – A Therapeutic Target for Bacterial Infection

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ABSTRACT

Microorganisms have developed intricate strategies to adapt and respond collectively to changes in their environment. One of the most well-understood among these is quorum sensing (QS)—a cell-to-cell communication process that allows microbial populations to sense their density and fine-tune gene expression accordingly. This process relies on the release and detection of small signalling molecules known as autoinducers, which allow microbes to assess their population density and act in a unified manner. Through QS, microbes regulate essential physiological activities such as biofilm formation, secretion of virulence factors, and the development of antibiotic resistance. QS signalling activation and biofilm formation lead to the antimicrobial resistance of the pathogens. Anti QS agents can abolish the QS signalling and prevent the biofilm formation. Therefore, Anti QS agents might be treated as potential alternatives for Antibiotics, used in healing Bacterial Infection.

Keywords: Quorum Sensing; autoinducer; bacterial infection; antibiotics

Metanil Yellow Triggers the Oxidative Stress Induced Damages of the Cytoarchitectural Structures of Brain Tissue in Rats

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ABSTRACT

Metanil yellow (MY), a non-permitted monosodium salt of 3[[4-(phenylamino) phenyl] azo] benzenesulfonic acid, is used as food color in different unorganized food processing sectors in India. The aim of the present study was to examine the effect of metanil yellow (MY) on the function of hypothalamus (brain), the activities of the antioxidant enzymes in brain tissue homogenate and structural alterations in hypothalamic tissues in MY exposed rat. The rats were exposed to different doses (250, 500 and 750 mg/kg BW/day) of MY for 20 and 30 days treatment durations. I found a significant decrease in the activities of superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), Glutathione reductase (GR), and glutathione-s-transferase (GST) of MY treated rats dose dependently in both 20 and 30 days treatment durations compared to the control groups of rats. Moreover, the amount of MDA production has been increased significantly in dose dependent manner in MY treated rats compared to the control rats. A little dispersion was observed between granule cell layer and purkinje cell layer in cerebellum of MY treated rat dose dependently compared to the control rats in both durations. This result suggests that MY might induces molecular degenerations in hypothalamus controlling the pituitary functions. From the results, it may be concluded that MY depresses the function of hypothalamus probably by inducing oxidative stress induced damages of the cytoarchitectural structures of hypothalamic neurons.

Keywords: Metanil yellow, cerebellum, oxidative stress, hypothalamic neurons.

In Vitro Mortality Assessment of *Bothriocephalous Achielognathi* Using Phytotherapeutic Agent

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ABSTRACT

The increasing resistance of helminths to conventional anthelmintic drugs has led to the exploration of plant-based alternatives with potential antiparasitic effects. This study evaluates the in vitro anthelmintic activity of *Berberis lycium* and *Calotropis procera* against the cestode *Bothriocephalus acheilognathi*, a common intestinal parasite in freshwater fishes. Adult worms were collected and exposed to aqueous and ethanolic extracts (20 mg/ml) of both plants. Praziquantel and phosphate buffer served as positive and negative controls, respectively. Parasites were incubated at 20°C, and time to paralysis and death was recorded. Death was confirmed by lack of response to warm water and microscopic observation. Results indicated that ethanolic extracts were more effective than aqueous ones. Praziquantel induced complete death within 2–3 hours, while alcoholic extracts of both plants caused full mortality by 4 hours. Among aqueous extracts, *B. lycium* showed slightly stronger activity than *C. procera*, achieving total mortality by 5 hours. These findings suggest that both plants possess significant anthelmintic properties, likely due to the presence of alkaloids, saponins, tannins, and flavonoids. Therefore, *B. lycium* and *C. procera* could serve as eco-friendly and affordable alternatives to synthetic drugs. Further in vivo studies and phytochemical investigations are recommended to identify the active compounds.

Key words: *Bothriocephalus acheilognat; Berberis lyceum*; *Calotropis procera*

Evaluation of Elemental Enrichment in the Water, Sediment Followed by Bioaccumulation in Muscle and Genotoxicity in Red Blood Cells of Inhabiting Fish of Ajay River, West Bengal

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ABSTRACT

The Ajay River ecosystem in west bengal, India has vital environmental challenges to elemental toxicity. This study assesses the levels of elemental enrichment in water and sediment and its impact on inhibiting fish. This result shows significant bioaccumulation of elements in fish muscle tissue and genotoxicity damage in red blood cells. The finding highlights the need for regular monitoring of elements enrichment to ensure ecosystem sustainability. The result of the study has important implications for understanding the molecular mechanisms underlying elemental toxicity in aquatic organisms. The bioaccumulations of elements in fish muscle tissue and genotoxic effect in red blood cells suggest potential risk to human health and the ecosystem. Therefore, it is crucial to develop effective management strategies to mitigate the impact of elemental enrichment on the Ajay River ecosystem. This research contributes to the growing body of evidence on the impact of elemental enrichment on aquatic ecosystems. The finding can inform policy decision of management practices aimed at protecting the Ajay River ecosystem and promoting sustainable development by understanding the effects of elemental enrichment on aquatic organisms' health, sustainability of ecosystem can be preserved.

Keywords: Elemental Enrichment; bioaccumulation; genotoxicity; aquatic ecosystems; Ajay river.

Toxicity Effect of Zinc on Haemocytes of Mud Crab, *Scylla* sp.

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ABSTRACT

Crabs are economically important as they serve as food source to man. But their natural environment is being disturbed by toxic pollutants. The metals such as arsenic, lead, mercury, copper, zinc and cadmium cause various toxicological effects on growth. They induce adverse effects on the aquatic biota. Zinc is also known to play a central role in immunity. In vertebrates, this metal is crucial for functioning of immune cells and the cellular activation of immune system can be deregulated by zinc deficiency. However, at high concentrations zinc can be potentially toxic to organisms. Edible live mud crabs (*Scylla* sp.) were exposed to Zinc Sulphate at 0.45 mg/L in water in glass aquaria. Haemolymph of crabs was collected and smeared on glass slides. Haemocytes were fixed by methanol and stained by Giemsa, and neutral red. Haemocytes from control crabs showed normal cyto-morphology and behaviour. The mean number of pyknotic cells were increased in treated group. Mean number of cell aggregates after treatment of Zinc Sulphate on glass slides was reduced which may affect immune responses. The results may provide information of the risk assessment of Zn in aquaculture.

Keywords: Haemocytes; Pollutants; Zinc.

Zooplankton Dynamics in Post-Mining Landscapes: A Case Study of Raniganj Coal Field Pit Lakes

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ABSTRACT

The present study explores zooplankton dynamics and the impact of environmental parameters on the zooplankton community structure and diversity in West Bengal coal mining pit lakes. Marked seasonal differences were observed in major parameters such as temperature, dissolved oxygen, salinity, phosphate, and water transparency. A total of 53 species of zooplankton, including rotifers, cladocerans, and copepods, were identified through the study. Rotifera dominated over all the lakes, with Cladocera ranked second. Species diversity was not uniform among the lakes. Shannon diversity index indicated that the pit lakes were experiencing moderate pollution stress. The lakes were identified as mesoeutrophic, which means that human activity and changed water flow have resulted in nutrient enrichment. ANOVA validated significant spatial and temporal variation in zooplankton abundance with peak numbers occurring during the monsoon period.

Keywords: Pit lake, Zooplankton, Rotifera, Cladocera

Artificial Light at Night (ALAN): A Growing Threat to Insect Ecology and Biodiversity

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ABSTRACT

Light pollution, a byproduct of urbanization, has emerged as a significant ecological stressor impacting nocturnal organisms, particularly insects. Artificial light at night (ALAN) disrupts circadian rhythms, interferes with mating, foraging, and navigation, and ultimately affects survival and reproduction of nocturnal insects, such as moths, beetles, fireflies, and midges, leading to altered community structures and biodiversity loss. This artificial light pollution increases the risk of predation and ultimately leads to the population decline of such insects. The decreased population size and neuro-hormonal imbalance, due to disrupted circadian rhythm, finally lead to reduced number of pollinators, which in turn is reflected in low agricultural productivity. This review synthesizes the current understanding of how light pollution affects insect behavior and biodiversity, focusing on Indian and global perspectives. It also discusses ecological consequences, methodological challenges in assessing ALAN impacts, and the need for conservation strategies, including light management policies and eco-friendly lighting solutions. With India experiencing rapid urban expansion, the conservation of nocturnal insect biodiversity requires immediate scientific and policy interventions.

Keywords: Light pollution; artificial light at night (ALAN); circadian rhythm; nocturnal insects.

Larvicidal Activity of Synthesized Silver Nanoparticles from Leaves of *Tiliacora acuminata* for Control of Filariasis

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ABSTRACT

In the present study it was established that efficacy of synthesized silver nanoparticles (AgNPs) from leaves of *Tiliacora acuminata* against 3rd instars larvae of filarial vector, *Culex quinquefasciatus* mosquito. Different concentrations of (1-5 ppm) of synthesized AgNPs were tested against *Cx. quinquefasciatus* larvae. Characterizations of AgNPs were carried out by Uv-vis spectrophotometer, X-ray diffraction (XRD), scanning electron microscopy (SEM), and transmission electron microscopy (TEM) procedure. Cent percent mortality was observed in 5 ppm concentration of synthesized silver nanoparticles against 3rd instars larvae of *Cx. quinquefasciatus*. UV-vis spectrophotometer confirme4d synthesized of nanoparticles (AgNPs) from leaves of *T. acuminate* with maximum absorption band at 450 nm. Scanning electron microscopy confirmed rough surface of synthesized nanoparticles. From TEM analysis it was revealed that shape of nanoparticles was ranging from oval to quasi spherical with their average diameter 50-70 nm. Their crystalline structure was confirmed by X-ray diffraction pattern. It is concluded that synthesized silver nanoparticles (AgNPs) from leaves of *T. acuminata* established excellent mosquito larvicidal activity against *Cx. quinquefasciatus* mosquito.

Key words: *Culex quinquefasciatus*; *Tiliacora acuminate*; silver nanoparticles; larvicidal activity

Gut Microbiota and Detoxification

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ABSTRACT

The human gut microbiota, comprising trillions of microorganisms, plays a vital yet often underappreciated role in detoxification processes within the body. Beyond aiding digestion and immune function, these microbial communities significantly influence the metabolism and elimination of various pollutants, including heavy metals, xenobiotics, food additives, and environmental toxins. Certain gut bacteria produce enzymes such as β-glucuronidase, azoreductase, and nitroreductase, which are involved in the transformation of toxic compounds into less harmful or more easily excretable forms. Moreover, microbial fermentation leads to the production of short-chain fatty acids (SCFAs), which strengthen gut barrier integrity and reduce systemic toxin absorption. Gut microbiota also interacts with hepatic detoxification pathways, modulating the efficiency of Phase I and Phase II biotransformation processes. Disruption of the gut microbiome—due to antibiotics, poor diet, or exposure to environmental pollutants—can impair detoxification capacity and increase susceptibility to toxin-induced diseases. Conversely, dietary interventions, prebiotics, probiotics, and fermented foods can help restore microbial balance and enhance the body's detox mechanisms. This topic explores the emerging understanding of gut microbiota as a critical component in the physiological detoxification network. Emphasis is placed on the mechanisms of microbial detoxification, the implications of dysbiosis, and potential therapeutic strategies to support gut-mediated toxin clearance.

Keywords: Microbiota; Detoxification; Toxins; Dysbiosis; Metabolism

Monocrotophos Induced Compromised Reproductive Fitness in *Drosophila melanogaster* Male Individuals

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ABSTRACT

Reproduction is an essential attribute of all living beings for the survival and continuity of all living organisms. It facilitates convey of genetic material from one generation to the next and make sure the existence of a species on earth. Moreover, reproduction is regulated by complex interactions between genetic, hormonal, environmental, and behavioral factors. Monocrotophos (MCP), a widely used pesticide is used predominantly in cotton, paddy, potato and tomato fields. Current study focuses on the effects of MCP exposure on reproductive performance in *Drosophila melanogaster*, a well-established model for toxicology, nutritional biology, molecular biology and many other fields. The specific as well as critical studies in invertebrate model are still underexplored. At first freshly hatched 1st instar larvae were reared to sub-lethal concentrations of MCP via dietary intake till adulthood and male flies were taken for assessment. Interesting findings has been observed viz., compromised gonadal heath and reproductive enzyme levels after chronic treatment with MCP. Wing deformity along with compromised physical fitness was observed. ROS induced abnormalities were found in testes, suggesting gonadal toxicity. In addition, ROS induced altered biochemical homeostasis and genotoxicity were also observed. Since *Drosophila melanogaster* shares significant genetic, biochemical and developmental homologies with higher vertebrates thus, the present study can be extrapolated to the other non-target organisms.

Keywords: Monocrotophos; *Drosophila melanogaster*; Oxidative stress; Reproductive toxicity

Neem Leaf Preparation Induces Apoptosis of Tumor Cells by Releasing Cytotoxic Cytokines from Human Peripheral Blood Mononuclear Cells

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ABSTRACT

A neem leaf preparation (NLP) was evaluated for its ability to induce apoptosis in tumor cells, aiming to clarify the mechanism behind its immunoprophylactic effect on tumor growth inhibition. NLP did not directly trigger apoptosis in human tumor cell lines KB, MCF7, and K562. Instead, it was used to stimulate human peripheral blood mononuclear cells (PBMCs) for 72 hours. The culture supernatant collected from these NLP-treated PBMCs (NLP-CS) was found to both inhibit tumor cell proliferation and induce apoptosis. Enzyme-linked immunosorbent assay (ELISA) showed that NLP-CS contained cytotoxic cytokines, IFN-gamma and TNF-alpha. Blocking the secretion of these cytokines from NLP-CS significantly reduced tumor cell apoptosis. Additionally, exposure of tumor cells to NLP-CS led to increased expression of caspase-3 and decreased levels of Bcl-2 and cyclin D1. Together, these findings suggest that NLP promotes tumor cell apoptosis by stimulating human PBMCs to release cytotoxic cytokines.

Keywords: Apoptosis; Neem Leaf Preparation; Tumor cells; Cytotoxic Cytokines

Dietary Antioxidants Attenuate Clothianidin-Induced toxicity in *Drosophila melanogaster*

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ABSTRACT

Clothianidin ((E)-1-(2-chloro-1,3-thiazol-5-ylmethyl)-3-methyl-2-nitroguanidine) is a systemic neonicotinoid pesticide extensively used in Indian agriculture to protect crops like rice, maize, cotton, and sugarcane from sucking (aphids, jassids, whiteflies) and chewing pests (stem borers, beetles, caterpillars). Despite its effectiveness, Clothianidin poses serious risks to non-target organisms like *honey bee* and monarch butterfly. *Drosophila melanogaster*, or fruit fly, is a preferred model in toxicology due to its short life cycle, high fecundity, and genetic similarity to humans. Previous studies have established Clothianidin's toxicity in *Drosophila*. Current study evaluates the ameliorative effects of three common dietary antioxidants—Vitamin C, Vitamin E, and Curcumin—each co-administered with Clothianidin. MTT assay of gut and fat body cells showed reduced cell viability, indicating mitochondrial dysfunction. Trypan blue assay confirmed tissue damage in alimentary canal. Elevated lipid peroxidation (LPO) levels suggested oxidative stress. Behavioural assays depicted reduced larval crawling and larval photosensitivity, which is significantly improved by co-treatment with antioxidants. In summary, it was observed that, co-administration of Vitamin C, Vitamin E and Curcumin reduced the Clothianidin induced cellular, biochemical, and behavioural toxicity in *D. melanogaster*. Furthermore, these findings can also be extrapolated to other non-target organisms.

Keywords: *Drosophila melanogaster*; Clothianidin; Oxidative stress; Dietary antioxidant

Evaluation of the Acute Toxicity of Malathion on Fingerlingss of *Channa punctatus*

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ABSTRACT

Malathion, an organophosphate insecticide is acetycholinesterase inhibitor that has potential to contaminate the ground water. The 96 hours LC_{50} value of malathion was determined in four-month-old Fingerlingss *Channa punctatus* with a body weight 1.52 ± 0.40 g and body length 6.29 ± 0.80 at 32 ± 1°c temperature. LC_{50} value was determined using finney method. The LC_{50} value was 2 ppm for 96 hours.

Keywords: Malathion; organophosphate; *Channa punctatus*

Wolbachia based method of Mosquito Control

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ABSTRACT

Mosquito-borne diseases like malaria and dengue severely impact global health. Dengue is the most important viral infection spread by mosquitoes, causing about 400 million infections each year and is endemic in over 100 countries, especially in Southeast Asia and the Americas. The spread is worsened by the global expansion of the mosquito vectors *Aedes aegypti* and *Aedes albopictus*, fueled by urbanization and climate change, which increase mosquito breeding and contact with humans. Currently, there is no publicly available vaccine or treatment for dengue. Traditional control relies on insecticides, but resistance among mosquitoes reduces their effectiveness, leading to higher disease transmission. Alternative control strategies—such as novel insecticides, genetically modified mosquitoes, sterile insect releases, and protective equipment—may also harm the environment. Innovative approaches involve using biological microorganisms for mosquito control. Recently, attention has focused on *Wolbachia*, a maternally inherited bacterium found in mosquito tissues. *Wolbachia* can disrupt mosquito reproduction and reduce their ability to transmit pathogens. These properties make it a promising tool in combating mosquito-borne diseases and limiting their spread. This overview highlights the limitations of existing mosquito control methods and the potential of biological solutions like *Wolbachia* for more effective and sustainable disease prevention.

Keywords: Mosquito; *Wolbachia*

Sustainable Sericulture in Non-Traditional Regions: Evaluation of Mulberry Silkworm Rearing Performance in Hooghly District, West Bengal

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ABSTRACT

The pursuit of sustainable and climate-resilient livelihoods in rural India has prompted renewed interest in sericulture, particularly in regions beyond its traditional strongholds. This study, conducted between 2020 and 2024, investigates the feasibility and performance of mulberry silkworm (*Bombyx mori* Linnaeus, 1758) rearing in Hooghly district, West Bengal—a largely industrial yet agriculturally active region lacking a history of commercial sericulture. Four commonly cultivated breeds—two multivoltine (Nistari Plain and Nistari Marked), one bivoltine (SK6 × SK7 hybrid), and one F1 hybrid (Nistari × SK6 × SK7)—were evaluated across all seasons for key rearing metrics: larval duration, cocoon and shell weight, effective rate of rearing (ERR%), absolute silk content (ASC), and yield per 10,000 larvae. Meteorological parameters were concurrently recorded to assess climatic influence. Findings revealed that late autumn (Oct–Nov) and early spring (Feb–Mar) offered the most favourable climatic windows, yielding optimal cocoon quality and silk output. The results indicate strong promise for Hooghly as a candidate for sericulture expansion. Multivoltine breeds proved robust, while F1 hybrids and bivoltines delivered higher economic return. The integration of sericulture into non-traditional districts may help address rural economic asymmetries and support India's sustainable development goals (SDGs).

Keywords: *Bombyx mori*; Sericulture; Climate resilience; Sustainable agriculture

HsfA2: Central Mediator of Plant Adaptation to Heat Stress

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ABSTRACT

Heat stress is a major abiotic factor affecting plant growth, productivity, and survival worldwide. Plants respond to elevated temperatures by activating a conserved heat stress response pathway, in which Heat shock transcription factors (Hsfs) play a pivotal role. Among them, HsfA2 has emerged as an essential regulator, rapidly induced under heat conditions to orchestrate downstream molecular chaperone gene expression, such as HSP70 and HSP101. HsfA2 operates both independently and in coordination with other Hsfs, serving as a "memory factor" that maintains high expression of stress-responsive genes even after the initial stress subsides, thereby providing acquired thermotolerance. Recent studies have shown that HsfA2 interacts with other signaling molecules, and its function extends beyond immediate stress response to influencing developmental processes and cross-stress tolerance. Understanding HsfA2-mediated networks is crucial for developing crop varieties with enhanced resilience to heat stress, a pressing need in the context of global climate change. This abstract highlight recent advances in elucidating HsfA2's molecular functions and potential biotechnological applications for sustainable agriculture.

Keywords: Heat stress; HsfA2; Transcription factor; Plant thermotolerance

Impact of Chemically Synthesized Silver Nanoparticles Incorpotaed Feed on Haematological, Biochemimcal, Digestive Enzymes on *Danio rerio*- Zebra Fish

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ABSTRACT

Silver nanoparticles (AgNPs) have shown promising potential in enhancing biological processes due to their antimicrobial and bioactive properties. In this study, AgNPs were synthesized using a controlled chemical reduction method and characterized by UV-Vis spectroscopy, FT-IR, Scanning Electron Microscopy (SEM) and SEM E-DAX, XRD to confirm their size, shape, and stability. Zebrafish (Danio rerio) were exposed to low concentrations of formulated fish feed. Their growth, survival rate, and morphological development were monitored. Results demonstrated that AgNP exposure at optimal concentrations significantly enhanced zebrafish growth, increased survival rates, and promoted improved fin and body length development compared to the control group. Hematological indices such as hemoglobin, red and white blood cell counts, and hematocrit were analyzed to assess blood health. Biochemical markers including total protein, carbohydrate, and Lipid were measured to determine metabolic and physiological responses. Digestive enzyme activities (amylase, protease, lipase) were also evaluated to understand potential impacts on nutrient assimilation. The results demonstrated that lower concentrations of AgNPs significantly improved hematological and digestive enzyme profiles without inducing toxicity, while higher doses caused mild alterations in biochemical parameters. These findings suggest potential for AgNPs as a functional feed additive under optimized dosage conditions.

Keywords: Silver Nanoparticles; Zebra Fish; Digestive Enzyme; Hematology

Effects of Mangiferin and Mango Peel Extract on Adrenal Gland and Kidney of Hypertensive Rat

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ABSTRACT

The ethanolic extract of *Mangifera indica* Linn. is recognized for its antihypertensive effect and has a traditional medicine background. Mangiferin is the primary active biological compound found in *Mangifera indica* species and exhibits the greatest biological activity, succeeded by benzophenones, phenolic acids, and other antioxidants including carotenoids, flavonoids, isoquercetin, quercetin, tocopherols, and ascorbic acid. Wistar rats (n=6 each) were treated for 21 days as follows: control (Tc) (normal diet + water), salt-loaded (Ts) (2% salt water + normal diet), salt-extract-loaded (Tse) (2% salt water + normal diet + 200mg/kg b.w. extract), and salt-mangiferin-loaded (Tsm) (2% salt water + normal diet + 200mg/kg b.w. mangiferin). The study focused on analysing the urinary space in the Bowman capsule and the general anatomical layout of the kidney. Structural modifications in the adrenal gland and serum aldosterone hormone levels. Mango peel extract and mangiferin were demonstrated to effectively normalize kidney function by decreasing hypertensive effects. Additionally, modulate the synthesis of aldosterone by promoting the regeneration of the cortex.

Keywords: *Mangifera indica*; Mango peel; Mangiferin; Hypertensive; Aldosterone

Establishing AMACR as an AR-Derived Biomarker in Prostate Cancer: Metabolic and Androgen-Mediated Mechanisms

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ABSTRACT

Prostate cancer (PCa) progression is primarily driven by androgen receptor (AR) signaling, which orchestrates tumor proliferation and metabolic reprogramming. Alpha-Methylacyl-CoA Racemase (AMACR), a key enzyme in branched-chain fatty acid β-oxidation, is widely recognized as a diagnostic marker for PCa, yet its regulatory association with AR and functional implications remain unclear. Using globally available multi-omics datasets, we analyzed RNA-seq profiles from TCGA-PRAD, revealing significant overexpression of AMACR in tumors compared to normal tissues ($p < 0.001$). Elevated AMACR levels correlated with advanced Gleason scores, nodal positivity, and poor overall survival ($p = 0.027$). Functional insights from androgen stimulation and antagonism datasets, coupled with ChIP-seq analyses, demonstrated direct AR occupancy at enhancer regions near AMACR, confirming androgen-dependent transcriptional regulation. Protein-level evidence from immunohistochemistry and immunofluorescence supported these findings. Collectively, these results establish AMACR as an AR-regulated biomarker in PCa, implicating it in metabolic dysregulation and disease aggressiveness, and highlight its potential as a therapeutic target within the androgen-driven oncogenic network.

Keywords: Prostate cancer, AMACR, Androgen receptor, Biomarker

Migratory Bird Diversity in Northern Bengal: Ecological Insights and Conservation Implications

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ABSTRACT

Northern Bengal, situated at the confluence of the Eastern Himalayas and the Gangetic plains, serves as an important stopover and wintering ground for a diverse range of migratory birds. The region's varied habitats—comprising hilly areas, wetlands, grasslands, riverine ecosystems, and forested areas—offer suitable conditions for both waterfowl and terrestrial migrants. This study aims to assess the diversity and distribution of migratory birds across selected sites in the Terai and Dooars regions during the winter months (November to March). Field surveys conducted at major locations such as Gajoldoba, Rasikbeel, Mahananda Wildlife Sanctuary, and the Teesta floodplains recorded 118 migratory species belonging to 36 families. Dominant groups included Anatidae, Scolopacidae, and Muscicapidae. Key sightings featured species like the Bar-headed Goose (*Anser indicus*), Eurasian Wigeon (*Mareca penelope*), Northern Shoveler (*Spatula clypeata*), and several flycatchers and warblers. Wetlands proved crucial for waterbird diversity, while forest edges and agroforestry zones supported passerine migrants. The study also notes temporal variations in species presence, with peak abundance observed between December and February. However, ongoing threats such as wetland degradation, human disturbance, and land-use change are negatively impacting habitat quality. The findings highlight the ecological significance of Northern Bengal for migratory birds and emphasize the need for habitat conservation, policy interventions, and community-based monitoring to safeguard avian diversity in the region.

Keywords: Diversity; Migratory; Abundance; Conservation

Ecological Consequences of Illegal Sand Mining in West Bengal's Aquatic Habitats

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ABSTRACT

Illegal sand mining in West Bengal's rivers, notably the Ganga, Kangsabati, and Damodar, severely impacts aquatic ecosystems. This study examines the ecological fallout of unregulated sand extraction, focusing on specific impacts in West Bengal. Excessive mining disrupts riverbed morphology, causing channel incision up to 2 meters in the Kangsabati River and bank erosion rates of 10-15 meters annually in heavily mined areas. These changes increase turbidity by 30-40%, reducing dissolved oxygen levels below 5 mg/L, threatening species like the endangered *Pethia reval* and macroinvertebrates such as *Gomphus* larvae. Sand removal destroys spawning grounds, reducing fish populations by up to 25% in mined stretches of the Damodar. Riparian vegetation, critical for stabilizing banks, has declined by 15% along the Ganga's mined zones, exacerbating flood risks. Groundwater recharge has dropped by 20% in affected areas, impacting local agriculture. A case study of the Kangsabati River reveals a 40% decline in benthic diversity at mining sites compared to undisturbed sandchar habitats. Weak enforcement of the Mines and Minerals (Development and Regulation) Act, 1957, fuels these impacts. Sustainable alternatives like manufactured sand (M-sand) and stricter zoning are critical. Implementing remote sensing for real-time monitoring and community-led restoration can curb further degradation. Strengthening regulatory frameworks and promoting habitat restoration are essential to safeguard West Bengal's aquatic ecosystems.

Keywords: Illegal sand mining, aquatic ecosystems, West Bengal, biodiversity loss, riverbed degradation

Flubendiamide-induced physiological, histopathological, and Antioxidant enzyme alterations in *Tubifex tubifex* (Müller, 1774)

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ABSTRACT

The present study examined the acute toxicity of the pesticide flubendiamide on *Tubifex tubifex* under controlled conditions. The 96h LC_{50} with 95% confidence limit of *Tubifex tubifex* is 28.169 (19.883 - 33.784) mg/l. The 24, 48, 72 and 96h LC_{50} values of flubendiamide on *Tubifex tubifex* is 62.063, 47.715, 34.428, 28.169 mg/l respectively. As expected, none of the control worms died during the study. Physical observations indicated that flubendiamide exposure caused autotomy of the worm's caudal region and increased mucus secretion. Behavioural changes such as enhanced mucus production, a tendency to clump together, and body wrinkling were noted in worms treated with flubendiamide. Levels of Malondialdehyde (MDA), Catalase (CAT), Glutathione transferase (GST) and Superoxide dismutase (SOD) showed a significant increase following exposure to flubendiamide. Overall, flubendiamide induces stress responses at both biochemical and physiological levels, ultimately compromising the health and survival of the affected organisms. These results indicate that exposure to flubendiamide adversely affects the survival and behavioural patterns of *Tubifex tubifex* under acute conditions. Additionally, sublethal exposure leads to significant changes in oxidative stress enzyme activity. Sub-acute exposure to flubendiamide leads to histopathological alterations in tubificid worms. The correlation matrix, along with the Integrated Biomarker Response (IBR) index, was employed to evaluate the interrelationships among biomarkers, toxicant exposure, and stress responses induced by flubendiamide. This study suggests that the tubificid worm faces a moderate risk of reduced survival in aquatic environments contaminated with flubendiamide.

Keywords: Acute toxicity; flubendiamide; *Tubifex tubifex;* oxidative stress

Antimicrobial Potential of Fish Gut-derived BLIS in Controlling Fish Spoilage Microflora

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ABSTRACT

Fish, a rich source of essential proteins, lipids and micronutrients, is an integral component of global nutrition. However, its high perishability due to microbial activity, oxidative degradation and enzymatic spoilage poses significant challenges to storage and food safety. With increasing concerns over the health risks and environmental impact of synthetic preservatives, the search for natural, safe and effective alternatives has gained momentum. This study explores the antimicrobial potential of bacteriocin-like inhibitory substances (BLIS) produced by *Staphylococcus epidermidis* F5, isolated from the gut of Nile tilapia (*Oreochromis niloticus*). Among 64 bacterial isolates, strain F5 demonstrated the strongest antagonistic activity, as identified by biochemical profiling and 16S rRNA gene sequencing (Accession No. OR244403). The neutralized, catalase-treated, cell-free supernatant (NCCFS) of this isolate significantly inhibited major fish spoilage and pathogenic bacteria, including Listeria monocytogenes (ATCC 657) and *Pseudomonas aeruginosa* (ATCC 1688). Proteolytic enzyme sensitivity confirmed the proteinaceous nature of the inhibitory compounds. Partially purified BLIS also demonstrated same antimicrobial activity. These findings underscore the potential of BLIS derived from endogenous opportunistic fish pathogen as therapeutics.

Keywords: BLIS; Fish; *Staphylococcus epidermidis*; therapeutics

Cytotoxic and Antimitotic Effects of Leaf Aqueous Extract of *Streblus asper* Lour. In *Allium cepa* Root Apical Meristem Cells

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ABSTRACT

Streblus asper Lour. is a traditionally used medicinal plant of family Moraceae, which is indigenous to tropical countries such as India, Sri Lanka, Malaysia, Philippines and Thailand. The present study aimed to analyse the cytotoxic and antimitotic effects of leaf aqueous extract of *Streblus asper* in *Allium cepa* root apical meristem cells. *A. cepa* roots were treated with different concentrations of leaf aqueous extract of *S. asper* (LAESA) (0.5-4 mg mL $^{-1}$ up to 24 h) and studied for root growth retardation, mitotic index (MI), cytological and chromosomal abnormalities. The treated samples showed a concentration-dependent root growth retardation, decreased MI%, and increase in the various cytotoxic effects, like nuclear lesion, giant cells, sticky chromosome, hyperchromasia, vacuolated prophase and chromatid break in *A. cepa* root tip cells. Thus, this first report explores the potential cytotoxic and antimitotic effects of LAESA in *A. cepa* root tip cells.

Keywords: *Streblus asper*; Cytotoxicity; *Allium cepa* assay; Chromosomal abnormality

Gut Microbial Drivers of Colorectal Carcinogenesis and Tumour Microenvironment

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ABSTRACT

Colorectal cancer (CRC) ranks as one of the common causes of cancer-related mortality across the globe. An interesting feature of CRC is its close connotation with the gut microbiota. Studies of both human subjects and animal models have highlighted the role of certain microbial taxa—such as *Clostridium septicum, Escherichia coli, Fusobacterium spp., Helicobacter pylori, Streptococcus bovis, Enterococcus faecalis,* and *Bacteroides fragilis* — to the development of CRC. These microbes interact with epithelial cells of the colon and host immune components through the release of a wide array of proteins, metabolites, and macromolecules that promote CRC pathogenesis. Variations in microbial strain composition, shaped by factors such as ethnicity, geographical origin, gender, and dietary practices, are crucial for designing effective strategies for CRC screening, early diagnosis, and predicting therapeutic outcomes. This review will first assess the existing evidence of the gut microbiota-CRC connection, then evaluate the research gaps, and finally discuss the prospects of microbial modulation in harnessing tailored therapeutic approaches.

Keywords: Colorectal cancer; Dysbiosis; Gut microbiota; Therapeutics

Ontogeny of eye in *Labeo rohita*: Morphological Observations and Simultaneous Study of Correlation of Expression of cyp19a1 Gene and Aromatase Protein in Early Embryonic Stages

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ABSTRACT

The neurulation in fish is regulated by many crucial factors inside and outside the body. One of them is neurosteroid that is produced in the brain and regulates the development of the brain itself and the nervous system also. In this study the appearance and morphogenesis of eye in *Labeo rohita* early embryonic stages were observed and recorded along with the ontogenic expression of aromatase gene and protein in eye and brain (0-3 days post fertilization). Each developmental stage was observed under inverted light microscope and marked with changes up to the appearance of presumptive optic vesicle stage (0 dpf, 9 hpf) visible as a bulge at the primitive head region. Starting from this stage we observed the development and changes in the eye region up to functional eye stage (3 dpf, 72 hpf). Simultaneous whole mount immunofluorescence and RT-PCR studies to observe any correlation between early neurulation and zygotic aromatase gene and protein expression in this fish. The intense localization of aromatase protein solely in the optic region and brain lobes at these early stages and gene expression results supports its predetermined roles in the neurulation in this fish.

Keywords: Neurulation; Aromatase; Brain development; Ontogeny

A Review Study on the Gonadotropin Regulation in Ovarian Development, Oogenesis and Ovulation in Fish Model

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ABSTRACT

Ovulation is the normal physiological process that involves the release of mature eggs from ovaries in response to gonadotropin secretion from pituitary in fishes like in other vertebrates. The most potent C21 steroids mainly involved in final oocyte maturation and GVBD are 17 α-20-β dihydroxy 4-pregnen 3-one and 17α-20β DP. Thecal cell layers surrounding an ovarian follicle produces 17β hydroxyprogesterone in response to LH from pituitary and then transverses the basement membrane and enters the granulosa cell layers where 17β-hydroxyprogesterone, a potent maturation inducing hormone (MIH) is metabolized to 17α-20β DP by the increased activity of 20β-HSD. MIH binds with the specific MIH receptors located on the oocyte surface and lead to the formation and activation of maturation promoting factor (MPF) that acts as the ultimate inducer for the oocyte maturation and ovulation. The release of egg from the ovary also involves the LH induced expression of certain proteolytic enzymes such as matrix metalloproteinases (MMPs; including mmp2 and mmp19), disintegrin, plasminogen (plg) known to have significant role in the degradation of follicular wall and some hydrolytic enzymes are also released critical for follicle rupture ultimately leading to ovulation in fishes.

Keywords: Ovulation, 17 α-20-β dihydroxy 4-pregnen 3-one, MIH, MPF

Assessment of Biochemical Changes Due to Sub-Lethal Chronic Toxicity in *Labeo rohita* Exposed to Chloropyrifos and Neem Oil

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ABSTRACT

Chloropyrifos, an organophosphate pesticide, widely used across the state, while use of Neem oil as biopesticide is a restricted affair. A comparative toxicological implication of Chloropyrifos and Neem oil is lacking. This study is conceptualised to determine the LC50 values of Chloropyrifos (Commercial grade named as Dursban) and Neem oil on *Labeo rohita* and to further investigate the biochemical effects of two sub-lethal doses 1/2 of LC50 (0.021 mg/l) and 1/4th of LC50 (0.0105mg/l) of Chloropyrifos along with ½ of LC50 (22.32 mg/l) and ¼ th of LC50 (11.16mg/l) Neem oil. Among the biochemical parameters tested Serum glucose, cholesterol, triglycerides increased significantly ($p < 0.0001$) for both the sub-lethal doses of Chloropyrifos and Neem oil for a chronic exposure of 30 days in a dose and exposure dependent relationship but the level of increase is more for Chloropyrifos than Neem oil. Total serum protein and Liver glycogen showed a marked decline ($p < 0.0001$) for both the sub-lethal doses of Chloropyrifos and Neem oil, the decline being more prominent in Chloropyrifos than Neem oil when exposed for 30 days of chronic toxicity. Results indicates that Chloropyrifos is more harmful than Neem oil for non-target aquatic organism like fishes. Management strategies should be executed to treat pesticide contaminated agricultural run-off polluting nearby water bodies serving as culture hub of fishes.

Keywords: Chloropyrifos; Neem oil; Serum glucose; Liver glycogen; Cholesterol; triglycerides; total protein; *Labeo rohita*

Semio-chemical based Control of Gandhi Bug, *Leptocorisa acuta* (Thunberg, 1783) (Hemiptera: Alydidae)

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ABSTRACT

Rice (*Oryza sativa* L.) (Poaceae: Commelinids) is the principal source of food for more than half in West Bengal. The Gandhi Bug, *Leptocorisa acuta* (Thunberg, 1783) (Hemiptera: Alydidae), is a major pest of rice. To control this pest by semio-chemical (epicuticular wax) components of rice cultivars (Gobinda Bhog and Tulaipanji) play an important role in host selection and oviposition of the rice bug, *Leptocorisa acuta*. The GC-MS and GC-FID analyses of the epicuticular waxes indicated the presence of 8 n-alkanes, having chain lengths from n-C_{14} to n-C_{32} and 5 free fatty acids (FFAs) having chain lengths from $C_{16:1}$ to $C_{18:0}$. For olfactory attraction [female > male] and oviposition [female] the most stimulating synthetic-combined-mixture of the epicuticular wax components (n-C_{16}, n-C_{18} and n-C_{20}) and ($C_{16:1}$, $C_{18:3}$, $C_{18:0}$) in per plant equivalent quantity (565.399 ± 3.463 µg plant^{-1} and 963.715 ± 4.341 µg plant^{-1}, respectively) caused stronger behavioral responses (attraction and oviposition) than those observed for other treatments. This acted as the most preferred lure and has the potential to be a part of an alternative sustainable strategy to develop baited trap in Sustainable Pest Management (SPM) of *L. acuta* in the future.

Keywords: Epicuticular wax; n-alkanes; Free fatty acids; Baited trap; GC-MS; GC-FID; Semio-chemicals Sustainable Pest Management (SPM)

Demography and Ecological Management of Rice Brown Planthopper, *Nilaparvata lugens* (Stal)

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ABSTRACT

Rice (*Oryza sativa* L.) is the principal source of food for more than half of the world population and approximately 52% of the global production of rice is lost annually owing to the damage caused by different biotic factors in different agro-climatic zones. The rice brown planthopper, *Nilaparvata lugens* (Stal), is a major pest of rice in India and elsewhere. The newly hatched nymph feeds on the plant sap and undergoes five molts to become an adult depending on the availability of the food and other environmental factors. Both nymphs and adults penetrate the tissues of their rice host plants with their piercing-sucking mouthparts in order to ingest phloem sap. Damage is generally greater in the wet season than in the dry season. Today for intensive agricultural practices by using chemical pesticides are creating ecological imbalances and there is a growing global need for promoting environmentally sustainable agriculture practices by Ecological Pest Management (EPM). This study, aiming at investigating the population dynamics based ecological management of this pest, *N. lugens*, will be one of the most promising steps for sustainable production of rice and other such crops in near future.

Keywords: agro-climatic zones; piercing-sucking mouthparts**;** environmental factors**;** plant sap; ecological imbalances

Association of UMOD Gene Variant (rs12917707) with Increased Risk of Urolithiasis in West Bengal, India

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ABSTRACT

Background:

Genetic susceptibility is one of the major risk factors for urolithiasis (urinary stone disease). Our investigation was aimed to explore the possible association of UMOD (Uromodulin) gene variant rs12917707 with increased risk of urolithiasis in the population of West Bengal, India.

Methods:

A case–control study was carried out involving 152 urolithiasis patients and 144 age and gender-matched healthy controls. Epidemiological and clinical parameters were recorded. Peripheral blood sample along with kidney stone samples were collected from each study participant and genomic DNA was isolated from the peripheral blood sample. Then to find out the particular SNP rs12917707 of UMOD, specific region of the gene was amplified by polymerase chain reaction using specific oligonucleotide primers and then genotypes were determined by restriction endonuclease digestion and bi-directional DNA sanger sequencing, followed by sequence alignment between case and control individuals.

Results and conclusion:

Urinary calcium excretion was significantly higher in the patient group (p value < 0.0001). The 5'UTR variant rs12917707; C>A (p value = 0.041, OR 2.04; 95% CI 1.02-4.07) showed significant association with increased risk of urolithiasis in West Bengal population of India. Studies in people with different ethnicity and in larger cohort size are required to validate our finding and to provide conclusive evidence.

Keywords: UMOD; Polymorphism; Urolithiasis; genetic association

Fish Catch Composition from Pong Reservoir during Two Years

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ABSTRACT

Pong Reservoir, also called as Maharana Pratap Sagar Reservoir has been created by damming river Beas in year 1975. This reservoir is situated in Himachal Pradesh, India. It has surface area of 24,529 hectares at full reservoir level. Fish catch data was obtained from state fisheries department of Himachal Pradesh Govt. Fish caught during two years 2018-19 and 2019-20 is analyzed. During monsoon season fishing activities were not allowed for two months for conservation reasons. Fish catch dominated during the post monsoon season. During year 2018-19, 86.917 tons fish was caught out of 287.513 tons, during September month. During year 2019-20, 76.602 tons fish was caught during September month, after the close season. *Sperata seenghala* dominated the catch. It represented 59.2 percent catch during year 2018-19 and 60.3 percent catch during years 2019-20. *Labeo dero* was not in catch. *Labeo calbasu* was very less in catch. Minimum catch was contributed by *Hypophthalmichthys molitrix*. Gillnets were used for fish catching. Minimum harvestable size of the fish is already fixed. Minimum mesh size (knot to knot) of the gear is also fixed. Seed stocking was being done by the state department of fisheries. Fishermen have organized themselves into fisheries co-operative societies. Fish catch record is being maintained by the state department of fisheries at different levels. Strict conservation measures are being applied regularly. There are different welfare schemes for the fishermen. Fisheries were managed scientifically. Fishing activities are helping the fishermen in poverty alleviation.

Keywords: gillnets; fishermen; conservation

Diversity Patterns and Conservation Needs: Dragonflies and Damselflies (Odonata) of Bethuadahari Wildlife Sanctuary, West Bengal, India

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ABSTRACT

The present study deals with the species diversity of Odonata (dragonflies and damselflies) and underscores the urgent need for habitat conservation within Bethuadahari Wildlife Sanctuary located in Nadia district, West Bengal, India. Bethuadahari WLS was established in 1980 and covers an area of 67 hectares. It is situated in the Bethuadahari town of Nadia district. The sanctuary harbors a rich assemblage of flora and fauna, including a notable diversity of insects, mammals, birds, and reptiles. The vegetation is dominated by species such as *Dalbergia sissoo* (Indian rosewood), *Terminalia arjuna* (arjun), *Tectona grandis* (teak), *Shorea robusta* (sal), and bamboo. Odonates are ancient, hemimetabolous insects with both aquatic and terrestrial life stages. In the current study, 11 species from 9 genera and 2 families were recorded in Bethuadahari Wildlife Sanctuary. The family Coenagrionidae dominated among damselflies, while family Libellulidae was most prevalent among dragonflies. As natural predators of harmful insects, odonates serve as effective biocontrol agents. Their sensitivity to environmental fluctuations also makes them excellent bioindicators of freshwater health and climate impacts. Many odonate species have specific habitat requirements, making the conservation of unpolluted, undisturbed aquatic ecosystems imperative. The findings of this study provide important baseline data on the odonate fauna of the Bethuadahari WLS and importance of habitat conservation to survival of dragonflies and damselflies.

Keywords: Odonata; bioindicators; Bethuadahari; WLS; conservation

A Comparative Analysis of Electrophoretic Patterns of Protein Subunits in Different Tissues of Two Freshwater Fish Species *(Heteropneustes fossilis and Labeo rohita)* Using Gel Electrophoresis

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ABSTRACT

This study aims to conduct a comparative analysis of the electrophoretic patterns of protein subunits in two distinct fish species, namely Heteropneustes fossilis and Labeo rohita. All tissues were analyzed using 7.5% SDS-PAGE. The investigation focused on the gill, liver, intestine, muscle and brain tissues of both species. Notably, the gill and muscle tissues exhibited the highest number of protein bands, with counts of 10 and 7, respectively. Conversely, the intestine showed the lowest number of bands in both species with counts of 7 and 5, respectively. The study revealed homology in the protein bands, albeit with minor variations. In this study, we identified a greater number of protein subunits in the gill and muscle tissues of both fish species. The variations in protein bands observed across different tissues of the treated fish, along with the specific protein differences among individuals within the same species group, may provide insights into taxonomic challenges related to disputed species. Utilizing electrophoretic techniques, closely related species demonstrate numerous shared electrophoretic alleles, while also exhibiting fixed differences in certain alleles. When two distinct species show an identical number of electrophoretic fractions, a more thorough examination of the relative mobility of one or more bands may reveal clearly defined species-specific distinctions.

Keywords: Protein patterns; SDS –PAGE; Heteropneustes fossilis; Labeo rohita; tissues

Environmental Risk Assessment of Chromium in Economically Important Edible Fishes of East Kolkata Wetland System

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ABSTRACT

Heavy metals such as chromium persist in aquatic environments as a result of their resistance to biodegradation. In this study, Environmental Risk Assessment has been performed for presence and comparative bioaccumulation of chromium in the East Kolkata Wetland System. The EKWS is a rich source of economically and nutritionally important food fishes. In vivo and in vitro studies revealed a correlation between the field condition with that of the sub-lethal or chronic toxicant exposure. Accumulation of the heavy metal varies significantly among different fish tissues and maximum accumulation has been observed in kidney followed by liver. Generation of Reactive Oxygen Species in the concerned tissues were determined to evaluate the level of stress in the test fishes. Stress enzymes SOD and Catalase can be used as candidate biomarkers for assessing heavy metal pollution in fish, as the estimation of these two enzymes were marked with higher concentrations in liver and kidney. Apoptosis or programmed cell death, on exposure to lethal and sublethal concentrations of chromium, were measured and found to be significant, showing gradual increase in the rate of early apoptotic and late apoptotic cells with increase of chromium concentration and exposure duration. All these findings are significant to monitor and potentially manage the consequences of chromium pollution in the aquatic ecosystem and also indicate the safety of consumption of fishes.

Keywords: Chromium; edible fish; Environmental Risk Assessment; East Kolkata Wetland System

Autonomic Imbalance in Diabetic Neuropathy: Insights from HRV and Vibration Perception Threshold

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ABSTRACT

Type 2 diabetes mellitus (T2DM) is increasing in developing countries like India, with an estimated 77 million people over the age of 18 suffering from diabetes. One of the leading causes of death is cardiovascular mortality associated with cardiac autonomic neuropathy. The most reliable way to assess cardiac autonomic neuropathy is through the measurement of heart rate variability (HRV). Our aim to determine the impact of diabetic neuropathy on HRV parameters causing autonomic dysfunction in neuropathy patients in hospital-based set up. Total 250 patients with T2DM were screened by Vibration Perception Threshold (VPT) and divided into Non-neuropathy and Neuropathy (IEC/AIIMS/Kalyani/certificate/2024/418). 5 min ECG recording was done in Labchart software and analyzed by Kubios software. Among 250 diabetic patients, 112 are non-neuropathy and 137 are neuropathy. Independent t-test showed significant difference in VPT score between two groups ($p<0.001$). Mean heart rate ($p=0.001$), SDNN ($p=0.003$), SDNN/RMSSD ($p<0.001$) were significantly increased and RMSSD reduced ($p=0.006$) in neuropathy group as compared to non-neuropathy. Spearman's correlation analysis showed significant ($p<0.001$) association between SDNN/RMSSD and LF/HF ($p=0.019$) indicating potential link between time and frequency-domain HRV parameters. Linear regression revealed RMSSD and SDNN as significant predictors for neuropathy. An increased SDNN/RMSSD ratio and significant positive association between SDNN/RMSSD and LF/HF ratio in diabetic neuropathy indicates reduced parasympathetic modulation and autonomic imbalance.

Keywords: Autonomic imbalance; Peripheral Neuropathy; Type2 Diabetes Mellitus

Study of miRNA precursor sequences of Saccharum officinarum, Saccharum sp. & Sorghum bicolor.

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ABSTRACT

MicroRNAs (miRNAs) are the naturally occurring small single stranded non-coding RNA molecules that play a crucial role in the post transcriptional regulation of gene expression by interacting mRNAs in a sequence specific manner. In plants, miRNAs have always been a subject to extensive research to see their explicit roles in overall development, cell to cell communications, metabolism, responses to stress and pathogen invasion. The interactions between miRNAs and specific target mRNAs are primarily regulated by the secondary structural conformation of miRNAs. The secondary structure also determines how efficiently the miRNAs can bind with the RISC complex to carry out gene silencing. Here, we aimed at gaining profound understanding of the secondary structure of all possible miRNA precursor sequences (pre-miRNAs from which mature miRNAs are produced) for *Saccharum* and *Sorghum*, the two closest monocot relatives among the domesticated cultivated crops. Using computational approaches, altogether, 240 different pre-miRNAs were downloaded from miRBase (miRNA database) and were individually analyzed for the secondary structures using the UNAFold server. Three different structural patterns were observed in the secondary structures. The structural motifs primarily consist of stems, internal loops, bulges, and terminal loops. The pre-miRNAs of *Saccharum sp.* were found to have the most stable secondary structure with-193.05 kcal/mol free energy suggesting their resistance to nuclease in the cell. The Simple Sequence Repeats (SSRs) within the stem region of all pre-miRNAs were found to be predominant with many trinucleotides, tetranucleotides and less frequent pentanucleotide repeats. AUG/AUC was the most frequently observed trinucleotide among the studied precursors. The occurrence of these repeat sequences suggests their role in the proper functioning of miRNAs. Likewise, SSRs provide a molecular basis for the structural conformation of pre-miRNAs. All this information is substantially required for identifying miRNA targets and designing additional miRNA-based strategies to increase crop yields and enhance plant resistance to various environmental stresses.

Evaluation of the Agroecological Performance of Integrated Rice Fish Farming System of West Godavari district, Andhra Pradesh, India

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ABSTRACT

Agroecology has become a leading scientific and policy approach to food system reform, with applications at the field, farm, and entire food system levels. Sustainable livelihood, efficient use of resources, output, and preservation of ecological health and functioning are all guaranteed by agroecological transition. Many South Asian nations are beginning to view integrated rice-fish farming systems as the best means of achieving agroecological transition. In addition to producing fish as a secondary crop for small and marginal farmers, it provides a practical means of increasing rice output in an environmentally responsible way. As a result, it has recently drawn interest as a viable strategy to foster India's agroecological transition. IRFS exhibits the capacity to support environmental sustainability, revenue production, poverty reduction, and the best possible use of natural resources. Based on suggestions from a High-Level Panel of Experts (HLPE), the Food and Agriculture Organization (FAO) developed 10 standardized components to assess the agroecological performance of a food system. The team proceeded to develop 13 principles, which are a simplified version of the FAO's elements. The current study framework, which focuses on 52 characteristics pertinent to agroecological principles, was developed. By integrating rice-growing communities under the Andhra Pradesh Community Managed Natural Farming (APCNF) program, the government has piloted the adoption of IRFS in the West Godavari district of Andhra Pradesh state. After 20 focus groups were conducted in the research areas to understand the socioeconomic factors, a thorough survey of 200 families was carried out. To confirm other variables associated with crop health, diet quality, water productivity, and soil health, traditional physical assessments and biochemical testing have also been carried out. To ascertain how individual factors impact each of the thirteen trait-based agroecological principles, a statistical analysis has been conducted. The development of key performance indicators was based on this. The results show that recycling, soil health, economic diversification, and connectedness among pertinent stakeholders are the main principles impacting IRFS's performance in its region. Nonetheless, the decrease of inputs, social norms and ideals, fairness, and participation were the primary factors that helped the community manage its land and natural resources, promising the IRFS-based agroecological transition in West Godavari.

Key words: rice fish integration; agroecological transition; co-creation of knowledge

Impact Of Sulphur Supply on Root Morphology of Alfalfa (*Medicago sativa* L.) Seedlings

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ABSTRACT

This study examined the effect of different levels of sulphur (S) on the root structure of alfalfa (*Medicago sativa L.*) seedlings. Different concentrations of sulphur were used to soak the seeds, and germination was aided under controlled circumstances. Root length, surface area, volume, and diameter were measured with WIN RHIZO software. Results show that more available sulphur greatly promotes the growth of roots, making them longer and more extensive. On the other hand, low sulphur environments result in less ideal root development. These findings demonstrate how important sulphur is to alfalfa root system optimisation, which enhances nutrient intake and management. Comprehending the impact of sulphur on root morphology is crucial for optimising nutrient efficiency in the production of fodder, providing significant insights for agricultural methodologies.

Keywords: Alfalfa; root morphology; sulphur availability; WIN RHIZO software.

Morpho-molecular Identification of Fungal Pathogens Infecting Some Locally Growing Fruits and Vegetables of Darjeeling Himalaya.

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ABSTRACT

Fruits and vegetables are an essential part of the diet of rural residents because they are a rich source of vitamins and minerals. With a wide variety of wild plants and crops, the Darjeeling Himalayan region of India is regarded as one of the richest hotspots of plant biodiversity. The natural resources of wild fruits, vegetables, and habitats are fast losing due to a variety of human and natural causes including plant diseases, which calls for long-term and efficient control measures. The rapid identification of fungal disease by timely recognition of their symptoms is an effective management practice and may help control and prevent their spread and progress. In present study locally available contaminated fruits like avocado (*Persea americana*), bhadrasay (*Elaeocarpus sikkimensis*), passion fruit (*Passiflora edulis*), wall nut (*Juglans regia*) and plum (*Prunus demestica*) bitter tomato (*Solanum aethiopicum*) and tomato (*Lycopersicum esculentum* L.) were collected from naturally growing habitat of Darjeeling Himalya and subjected for fungal pathogen isolation. Pure fungal culture of the pathogen was developed in PDA plates and slants at Mycopathology laboratory, Department of Botany, Darjeeling Govt. college, Darjeeling. Verification of Koch's postulation was done. Morphological identification of the fungal culture was done by lactophenol cotton blue staining study. Molecular identification was done by isolating fungal genomic DNA followed by sequencing of PCR amplification of ITS region and 28s rRNA large subunits and further use of bioinformatics. Morpho-molecular identification techniques have identified fungi like *Fusarium* sp., *Mucor* sp. and *Cladosporium* sp. *Colletotrichum* sp. from locally growing fruits and causing diseases which will help in further control of these foliar diseases.

Keywords: Local fruits and vegetables; Darjeeling Himalaya; fungal disease; morpho-molecular identification

Eco-Nano Intervention: A Biogenic Strategy for Abiotic Stress Mitigation with Green Nano-particle

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ABSTRACT

Plants are constantly exposed to abiotic stresses such as drought, salinity, heavy metals, flooding, and extreme temperatures, which thwart growth, imperil development, and decimate crop yield. With increasing climate variability, the quest for sustainable and eco-friendly approaches to enhance plant resilience has become critically important. Phyto-nanotechnology has emerged as a promising strategy to mitigate such environmental stresses with minimal negative impact on ecosystems. Conventional methods of nanoparticle (NP) synthesis—through physical and chemical processes—often raised concerns for environmental risks and accumulation of toxic by-products in the environment. In contrast, green synthesis using biological sources such as plants, bacteria, fungi, and algae provides a safer, more sustainable alternative. Biogenic nanoparticles are naturally stabilized by reducing agents like plant secondary metabolites, eliminating the need for harmful chemical stabilizers and reducing environmental toxicity. This review work presents latest strides in the green synthesis of nanoparticles with varied sizes and shapes, emphasizing their role in enhancing plant tolerance to abiotic stress. It also explores how biogenic NPs strengthen plant defence mechanisms, support growth under adverse conditions, and contribute to maintaining crop productivity. Overall, biogenic nanoparticles represent a promising tool for building stress-resilient crops and promoting sustainable agricultural development.

Keywords: Nanoparticle; Biogenic NP; Abiotic Stress; Green Synthesis

Occurrence and Characterization of Fungal Foliar Pathogens in *Momordica dioica* (Kakrol) from Sub-Himalayan West Bengal

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ABSTRACT

Spine gourd (*Momordica dioica* Roxb. Willd), commonly known as Kakrol, is a perennial, rhizomatous, dioecious, climbing creeper belongs to the family Cucurbitaceae commercially cultivated in West Bengal and Karnataka. Cucurbits are the targets of various fungi and show records of new diseases. Among the biotic factors like pests and diseases, fungal pathogens cause 70% yield loss. Powdery mildew, anthracnose, downy mildew, angular leaf spot and mosaic are the major diseases found in spine gourd. In present study a survey was conducted during May to July, 2025 to search for the infected sample in sub-Himalayan region of West Bengal. Rotting and immature falling of fruits and leaf spots are the very common in this region. 40% disease incidence was recorded in present area. Pure fungal culture of the pathogen was developed in PDA and microscopic study was done. Verification of Koch's postulation was also done. Molecular identification was done by amplifying conserved gene by using ITS1 and ITS4 primer pair. Immature mycelia were hyaline in colour. Conidia of the fungus were beaked and having transverse septa and 10-40 µm X 6-12 µm in diameter. Based on the morphological characteristics the fungus was identified as *Fusarium* sp. causing leaf and fruit rot of spine gourd. Molecular study also confirmed the same pathogen. Present study will provide a direction to manage the yield loss caused by biotic factors.

Keywords: Momordica dioica; leaf and fruit infection; *Fusarium* sp.

Pollen Barcoding from *Avicennia alba* Blume in Putative Understanding of the Climate of Indian Sundarbans: A Novel Approach

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ABSTRACT

Pollen DNA barcoding is a powerful technique that enables precise identification of plant species by analysing specific DNA regions within pollen grains. This method is particularly valuable in ecosystems like the Indian Sundarbans, where traditional morphological identification is challenging due to the complex and often degraded nature of pollen grains. This study focuses on extracting the DNA from pollen of a salt-tolerant mangrove species *Avicennia alba* Blume by targeting two commonly used barcode regions: the chloroplast gene rbcL and the nuclear ribosomal ITS region, selected for their universality and effectiveness in distinguishing closely related species. High-throughput sequencing of the amplified barcode regions of *A. alba* when compared with a reference dataset (BLAST), revealed 1% dissimilarity with known sequences from the leaves of *Avicennia alba*, *Avicennia marina*, and *Avicennia officinalis*. The generated rbcL and ITS sequences for *Avicennia alba* are slated for submission to the NCBI database, contributing to global reference libraries essential for pollen DNA barcoding applications. This advancement is significant for ecological studies, allowing for the reconstruction of past vegetation patterns and biodiversity monitoring through the analysis of unknown soil samples, where pollen identification via microscopy becomes less feasible. By facilitating accurate species identification, pollen DNA barcoding enhances our understanding of plant diversity and ecosystem dynamics, supporting conservation efforts and the management of vital coastal habitats like the Sundarbans.

Keywords: *Avicennia*; Barcoding; Pollen; rbcL.

MicroRNAs as Cancer Biomarkers: Diagnostic and Prognostic Roles

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ABSTRACT

MicroRNAs (miRNAs) are small, noncoding, endogenous RNA molecules that typically have 20-24 nucleotides in length. This particular discovery in the year of 1993 by Victor Ambros and Gary Ruvkun has led to the insights of substantial importance in human biology and disease. Apart from performing post-transcriptional gene regulation, miRNA has a significant role in the treatment of cancer. In recent years, research has shown that miRNA has emerged as a potential biomarker with its diagnostic and prognostic roles. Experimental validation and comprehensive analysis have made a significant impact on the hallmark of cancer. Dysregulation of microRNA was found to be associated with the oncogenic pathways that influence tumour growth and invasion. Additionally, the potential of microRNA as diagnostic biomarker with its therapeutic target has been evaluated by highlighting their promise in cancer diagnosis & prognosis.

This paper will focus on the diagnostic perspective by aberrant miRNA expression that might able to distinguish between malignant and non-malignant tissues. Differentiating among the subtypes of cancer with the specific miRNA sequences, such as overexpression of miR-21, served as a potential biomarker that has been reported in case of breast and lung cancer.

In case of prognostic role, miRNAs have shown better outcome with the survival rate of patients. Low levels of mir-34a are correlated with a poor prognosis in hepatocellular carcinoma. Some findings may also suggest that miRNA may act as indicator with the progression of diseases. Technological advancements may significantly improve the specificity of miRNA profiling. Continued research with the validation of high-scale studies will play a significant role for early detection of cancer for a better outcome.

Keywords: miRNA; Potential Biomarker; Cancer; Prognosis

Enzymatic Prospecting for Jute Retting: Isolation and Characterization of Pectinolytic Bacteria from Untapped Ecological Niches

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ABSTRACT

Jute (*Corchorus olitorius* L.), known as the golden fiber, is a naturally occurring bast fiber that is biodegradable, eco-friendly, and recyclable, with significant industrial application. The process of extracting jute fiber involves microbial retting, where jute bundles are submerged in mildly flowing water. During retting, microbial enzymes break down gummy substances like pectin and hemicelluloses. In this study, 29 culturable bacterial specimens were isolated from a retting water sample collected from the natural jute retting wetland at Bortir Bill (22°47' N and 88°26' E), located in the North 24 districts of West Bengal. Among the presumptive pectinolytic strains, isolate B23 showed the highest pectinase production based on reducing sugar levels measured by the DNS method. The strong pectinolytic activity of B23 was confirmed through Thin Layer Chromatography (TLC), High-Performance Thin Layer Chromatography (HP-TLC), and Fourier Transform Infrared (FTIR) spectroscopic analysis. Additionally, we examined the microscopic features and optimized pectinase production from this specific strain. Molecular identification revealed that the potent B23 strain is most closely related (99%) to *Priestia aryabhattai*, now renamed as *Priestia aryabhattai* VB23. We also evaluated the retting efficiency of this strain through a small-scale retting trial in vitro. Interestingly, mature jute twigs incubated with the VB23 strain showed a shorter retting period compared to the control. As a result, the jute industry can enhance efficiency and productivity by utilizing a unique bacterial strain, thereby promoting sustainable jute production and ensuring consistent fiber quality.

Keywords: Jute retting; pectinolytic bacteria; pectinase; retting efficiency

Rice Phyllosphere-associated Bacteria Exhibited Plant Growth-Promoting Attributes and Stress Tolerance Phenotypes

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ABSTRACT

Phyllosphere, especially phylloplane are typically inhabited by diverse group of bacteria including different commensals, symbionts, and phytopathogens. Like rhizospheric bacteria, phyllosphere-associated bacteria have also been reported to exhibit different plant growth-promoting attributes. Metagenomic studies identified the abundance of diverse bacterial population in rice phylloplane. Plant-growth promoting roles of rice phyllosphere-associated microbes are less explored. We isolated a number of bacteria from rice phylloplane and 33 isolates were selected on the basis of their colony morphology and maintained as pure culture. Out of 33 isolates, 3 bacterial isolates were further selected and characterized on the basis of their significant growth-promoting phenotypes including auxin synthesis, potassium and phosphate solubilization, ammonia production, siderophore synthesis. Additionally, these isolates exhibited tolerance against different stress conditions like altered pH, salt, and heavy metals. However, these 3 bacterial isolates showed notable growth promotion, in terms of their morphological growth parameters and biochemical parameters, in mung bean seedlings under laboratory condition. Further, the isolates were identified through 16SrDNA sequencing and phylogenetic tree analysis. These bacterial isolates can be utilized for getting better crop yield and quality through an eco-friendly and sustainable agricultural practice.

Keywords: Phyllosphere; Plant Growth promotion; Stress tolerance; 16S rDNA sequencing

Gametophyte Culture of *Dryopteris redactopinnata* Basu & Panigrahi and Assessment of Bioactivity from the Ethanolic Extract and Comparative Soil Profiling of Collected Locations

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ABSTRACT

The present study explores the *in vitro* gametophyte culture of *Dryopteris redactopinnata* Basu & Panigrahi, a lesser-known fern species endemic to Eastern India. Sterilized spores were successfully cultured on Modified-Moorse (MM) medium supplemented with growth regulators to establish gametophyte colonies under controlled conditions. Micro-morphological development was observed under optimize conditions for sustained propagation. Ethanolic extracts were prepared from mature gametophytes and evaluated for antioxidant and antimicrobial activities using standard assays. The extracts demonstrated significant bioactivity, indicating potential pharmacological applications. In addition, a comparative analysis of soil samples from the plant's natural habitats in Darjeeling (hill zone) and Nadia (Gangetic plain zone) districts of West Bengal was conducted. Physicochemical parameters, including pH, moisture content, organic matter, EC, CEC, nitrate and nitrogen contents, were analysed. The results revealed significant differences in soil composition, potentially influencing the distribution and growth of *D. redactopinnata*. This integrative approach highlights the species' ecological adaptability and bioactive potential, supporting future conservation and propagation strategies.

Keywords: *Dryopteris redactopinnata*; Gametophyte Culture; Ethanolic Extract; Soil Analysis

Nanobionics Unleashed: Supercharging Plants for a Smarter Agricultural Future

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ABSTRACT

Nanobionics represents a cutting-edge fusion of biotechnology, nanotechnology, genetic engineering, robotics, and artificial intelligence, leading in a revolutionary era for modern agriculture. By integrating nano-sensors—such as carbon nanotubes—into plant tissues, crops can be endowed with "supernatural" abilities like real-time environmental sensing and communication. These intelligent systems convert biological responses into electrical signals, enabling advanced applications including drought detection, soil monitoring, and even glowing plants that function as living lamps. From smart dust tracking plant growth and microclimate shifts, to automated selfie-capturing plants, nanobionics blurs the line between biology and technology. As this field evolves, it promises to enhance plant productivity, sustainability, and human-plant interaction, offering transformative potential for global food security and ecological resilience.

Keywords: Nanotechnology; Nanobionics; Agriculture; Biosensor; AI

Biological Agent - '*Bacillus anthracis*'

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ABSTRACT

Bacillus anthracis is the etiological agent of anthrax, a zoonotic disease affecting herbivores and humans. It has gained notoriety not only for its pathogenic potential but also for its history and characteristics as a biological agent. Due to its spore-forming ability, environmental resilience, and high lethality in inhalational form, *B. anthracis* is classified as a Category A biological agent by the U.S. Centers for Disease Control and Prevention (CDC). It was discovered by a German physician Robert Koch in 1876, and became the first bacterium to be experimentally shown as a pathogen. It causes anthrax, a deadly disease to livestock and, occasionally, to humans. Its infection is a type of zoonoses, as it is transmitted from animals to humans. Anthrax is transmitted by inhalation, ingestion and enters through skin. The type of illness a person develops depends on how anthrax enters the body; through the skin, lungs, or gastrointestinal system. All types of anthrax can cause death if they're not treated with antibiotics. Anthrax disease is diagnosed by PCR, Direct Fluorescent antibody testing (DFAT), Antigen detection, Swab, blood and sputum culture etc.

Keywords: Biological agent; *Bacillus anthracis;* anthrax; U.S. Centers for Disease Control and Prevention

Analysis of Short Sediment Core Diatoms of the Indian Sundarbans as Proxies for Drawing Palaeo-Ecological Inferences

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ABSTRACT

The Indian Sundarbans is an area of paleo-ecological importance due to its unique structure and vulnerability to climate change. Unicellular, microscopic eukaryotic diatoms with ornamented, silicified cell walls are well-preserved in soil sediments. This research utilizes diatom populations present in sediment as indicators to investigate the timeline of environmental events recorded in a short sediment core from the Indian Sundarbans. A short soil core of 120 cm was collected from the Satjeria-Rajatjubili, and then it was segregated into samples at 10cm intervals, and each sample was studied to determine the composition of diatom assemblages at different depths. The pH and EC of the core varied from 7.3 to 8.1 and from 1.9 ms/cm to 5.4 ms/cm, respectively. Screening of each 12 layers in terms of diatom assemblage composition reveals that both centric diatoms remain dominant over pennate diatoms towards the surface of the core, whereas in deeper layers, pennate diatoms become dominant over the centric forms. Centric diatoms, such as *Cyclotella* sp. and *Coscinodiscus* sp., were consistently present in large numbers across all depth layers. In contrast, pennate diatoms, including *Diploneis* sp., *Giffenia cocconeiformis*, *Nitzschia* sp., and *Navicula* sp., were predominantly found in the 100-110 cm and 110-120 cm layers of the soil core. *Actinoptychus* sp is an indicator of historical aquatic environments, primarily linked to Miocene-age fossil deposits. This paper will extensively discuss the implications of using diatoms as proxies.

Keywords: Diatom; Sundarbans; *Cyclotella*; *Actinoptychus*.

Phytochemical studies on *Ansiomeles indica* (L.) Kuntze with special reference to antimicrobial potentiality against *Staphylococcus aureus*

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ABSTRACT

The members of Lamiaceae family include aromatic plants that are being used in traditional medicine for various disorders. The therapeutic application of these plants is attributed to the presence of secondary metabolites or phytochemicals such as alkaloids, saponins, flavonoids, glycosides and phenols. This study is a preliminary screening of phytochemicals of *Anisomeles indica* (L.) Kuntze Lamiaceae family from Govt. General Degree College, Kaliganj campus. Methanol, extracts of the plant was subjected to qualitative phytochemical screening. Tests for saponins, glycosides, tannins, flavonoids, steroids ring and terpenoids were conducted using the extracts. The results of the qualitative analysis of the studied leaf extract, revealed that the methanolic extracts were found positive for terpenoids, saponins, glycosides, tannins and negative for alkaloids and steroids. Antimicrobial assay also has been conducted for methanolic extract of leaf using agar well diffusion technique and disc diffusion method and found to be slightly effective against *Staphylococcus aureus.*

Keywords: Lamiaceae; Phytochemical, antimicrobial; *Anisomeles indica*.

Studies on the Stress Effects of High Temperature, Drought and Heavy Metals (Cu, Hg, Pb and Cd) on *Zea mays* L. in West Bengal

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ABSTRACT

Zea mays (maize) is an important staple crop in West Bengal, India, where it is frequently exposed to multiple abiotic stresses, including high temperatures, drought, and heavy metal contamination. The loo winds, characteristic of the region's hot summer months, exacerbate these stress conditions. This study investigates the individual and cumulative effects of high temperatures, drought, and heavy metals (copper, mercury, lead, and cadmium) on *Zea mays* plants. A controlled experiment was conducted to simulate the stress conditions prevalent in West Bengal during the loo-wind season. Physiological and biochemical parameters, including plant growth, chlorophyll content, antioxidant enzyme activity, and metal accumulation, were evaluated. The findings highlight the vulnerability of *Zea mays* to multiple environmental stressors and provide insights into potential mechanisms of plant response and adaptation. This research contributes to a better understanding of plant resilience in the face of climate change and heavy metal pollution, informing strategies for sustainable agriculture and ecosystem management.

Keywords: *Zea mays*; temperature, drought; stress.

Studies on Isolated Actinomycetes Strains from Rhizosphere of *Crotalaria pallida* Aiton from GGDC, Kaliganj campus

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ABSTRACT

Actinomycetes have provided many industrially important bioactive compounds having great economic importance and always being a curious organism for secondary metabolite production. These taxa have long been recognized as prolific producers of enzymes, antibiotics, anti-cancerous agents and play important role in recycling of organic matter. The objective of present work is to isolate random strain from rhizosphere of different plant species and observed under the microscope. The strain was isolated from the rhizosphere soil of the following species- *Crotalaria pallida* Aiton from the GGDC Kaliganj campus, Debagram. SCA media is used in the growth of Actinomycetes because it is supplemented with Nalidixic acid to inhibit the growth of fungi and other bacteria it is respectively making it a selective media for Actinomycetes. All isolated stains of the actinomycetes are Catalase positive meaning they produce the enzyme catalase which are break down hydrogen peroxide into water and Oxygen.

Keywords: Actinomycetes; isolation; rhizosphere; *Crotalaria pallida*.

Taxonomic Study of the Genus *Salvia s.l.* sect. Eurysphace (Lamiaceae) in India with Special Reference to Antimicrobial Compounds

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ABSTRACT

The genus *Salvia* L. is the largest genus in the family Labiatae/Lamiaceae with more than 1000 species, indeed one of the largest genera in flowering plants, and cosmopolitan in distribution In the Indian region, the genus is primarily found in the Himalayas with almost 50 taxa (Nepal Bhutan Pakistan data added). In this study, 24 species from India have been recorded from the political boundary of India. Salvia sect. Eurysphace E.Peter however are reported with 7 taxa. In this present work detailed illustrations, color photoplates, distribution with maps using QGIS 2.8 software of these taxa have been provided. A key also provided to aid in identification of different taxa. The synoptic taxonomic overview of the section with correct names, comprehensive synonymy, range, phenology and SEM studies of nutlet morphology has been provided. The genus itself is famous for its medicinal properties evident by its name which originated from the word '*Salvus'* meaning 'to heal' referring to its medicinal usage since ancient times. In this context, a comprehensive list of bioactive compounds that have been screened from the Indian members of the genus has been presented in this work. A discussion on the results of *in silico* studies on important antimicrobial compounds found in these species has also been made to put emphasis on the medicinal potentiality of these species.

Keywords: *Salvia;* Lamiaceae; India; Taxonomic Revision

Studies on Antibacterial Potentiality of Plant Extract of *Bergenia ciliata* (Haw.) Sternb., (saxifragaceae) from Dhanaulti, Tehri Garhwal, Uttarakhand

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ABSTRACT

The present study was based on plant extracts gained from *Bergenia ciliata* (Haw.) Sternb., that have massive antimicrobial potential. The plant sample were collected from Uttarakhand. Antibacterial activity of *Bergenia ciliata* (Haw.) Sternb. extracts were investigated using Minimum Inhibitory Concentration (MIC) method. No work on aqueous solution of extract has been reported successful, therefore needed to undertake. Aqueous extracts of *Bergenia ciliata* (Haw.) Sternb. were potentially useful with changeable efficiency against the tested bacterial strains at concentration of 10 mg/ml. *Bergenia ciliata* (Haw.) Sternb. aqueous extracts were maximum effective plant extracts and displayed bactericidal activities against the stains of aerobic bacterial strains with MIC ranged from 6,8 and 10 mg/ml and MBC of 10 mg/ml. It was also observed that the antibacterial potential of root is more than the leaf of *Bergenia ciliata* (Haw.) Sternb. These plant extracts can be therefore a natural substitute against antibiotics.

Keywords: Saxifragaceae; MIC & MBC; Antibacterial; *Bergenia ciliata.*

Study of Isolated Actinomycetes Strains from Rhizosphere of Selected Angiosperms of GGDC, Kaliganj campus

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ABSTRACT

The soil of rhizosphere is very important Agricultural field, and the bacteria of rhizosphere do play vital role for plant growth and development. The objective of this work is to select random strain from rhizosphere of different plant species, some of which are medicinally important and to observed it under microscope. The strain was isolated from the rhizosphere soil of the following species- *Crotalaria pallida* Aiton*, Ocimum tenuiflorum* L.*, Curcuma longa* L.*, Azadirachta indica* A. Juss.*, Bergenia ciliata* (Haw.) Sternb.*, Syzygium cumini* (L.) Skeels, Using Starch Caesin Agar (SCA) Media which is specific to actinomycetes. The strains were tested for Catalase positivity and Gram stained to know their Gram staining nature.

Keywords: Actinomycetes; rhizosphere; Fabaceae; SCA media.

Study of Water Quality of Water Bodies in Panighata Region Using Diatoms as Indicators

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ABSTRACT

Diatoms are important indictors of fresh water ecosystems. They can be used to study the dynamics of phycochemical parameters of water bodies due to their sensitivity to different attributes of water such as pH, salinity etc. In this study of water quality of water bodies in Panighata region of Debagram, Nadia was studied using Diatoms as indicators due to their sensitivity to range of environmental conditions as mentioned. The water sample were collected different water bodies of Panighata region. The collection site includes water from Paglachandi River and from different local ponds as well. The water pH and turbidity were measured. In this present work different attributes such as pH of water of water bodies were observed and these parameters were used to link with the alpha diversity of diatoms present in the respective River ecosystem and in different water bodies.

Keywords: Diatoms; Water quality; Panighata River; Water bodies.

Mind over Spine During Spinal Anesthesia

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ABSTRACT

Several complications can happen during spinal anesthesia like spinal cord injury, neurological problems, backpain, and even some infections. In some cases, patients have problem urinating. Knowing about these complications often put the patients in distress even before the anesthesia. The aim of this review was to identify the problems and their probable solutions. Appropriate articles were searched in Google scholar by using keywords like spinal anesthesia, trauma during anesthesia etc. Perfect types and sizes of needles were very important to avoid these kinds of problems. Along with that the position of the patient during insertion of needles was also crucial. Continuous monitoring should be done during spinal anesthesia to avoid any negligence as patient may feel pain if proper monitoring was not done. Before applying the doses of anesthesia, patients should be examined properly for any complications or comorbidities, if any. Spinal anesthesia needs proper care and attention otherwise it will be traumatic for patient. It will help both patients and health care providers to manage the problem.

Keywords: spinal anesthesia; trauma; injury

Neuroendocrinological Link between Menopause & Mind

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ABSTRACT

Menopause is a natural phase in a woman's life that brings physical changes along with some difficulties in brain function, including memory. Menopause is defined as the permanent cessation of menstruation resulting from the loss of ovarian follicular activity. During menopause, the body goes through changes due to a drop in estrogen level which may affect both body and mind. Common symptoms include hot flashes, night sweats, tiredness, mood swings or anxiety. One important but less discussed problem is the effect of menopause on the brain. Many women find it harder to remember things or focus on tasks known as 'brain fog'. Menopause causes drop in 'estrogen', hormone that affects hippocampus & prefrontal cortex; depending on age, health and lifestyle. Lower estrogen levels can reduce the brain's ability to form connections between brain cells, neurotransmitter imbalance in hippocampus and prefrontal cortex that may lead to problem in memory processing. The endocrinological changes during menopause is widely studied but the effect in memory is not fully understood yet. Appropriate articles were collected from PubMed and Medline with keywords like 'menopause', 'memory', 'brain fog' etc. This review explores the effects of menopause on women's memory.

Keywords: Estrogen; menstrual cycle; hormones; hippocampus

Integrative Approaches to Alopecia: From Synthetic Treatments to Herbal Alternatives

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ABSTRACT

Alopecia, the medical term for baldness, refers to the partial or complete loss of hair from one or more regions of the body, most commonly the scalp. Hair loss may arise from multiple factors, including genetic predisposition, environmental influences, chemical exposure, certain medications, nutritional deficiencies, excessive stress, and chronic illness. Depending on the underlying cause and pattern, alopecia is classified into several forms, of which androgenetic alopecia and alopecia areata are the most prevalent and clinically significant. Currently, a range of synthetic therapeutic agents—such as minoxidil, corticosteroids, dithranol, systemic cortisone, tretinoin, zinc supplements, immunosuppressants, irritants, azelaic acid, and finasteride—are employed to manage alopecia. However, these conventional options often produce suboptimal or short-lived outcomes and are frequently associated with adverse reactions, including pruritus, erythema, dermatitis, flaking, and irritation. In recent years, natural remedies have gained increasing attention as safer and more sustainable alternatives. Numerous medicinal herbs have demonstrated promising activity in combating alopecia through diverse mechanisms, including nutritional support, inhibition of 5-α-reductase and dihydrotestosterone (DHT), enhanced scalp circulation, and aromatherapy. Compared with synthetic drugs, herbal approaches offer notable advantages such as better patient compliance, minimal side effects, affordability, widespread availability, and multifunctional therapeutic benefits. This review emphasizes the multifactorial nature of alopecia and highlights the potential of natural interventions as cost-effective and holistic strategies for hair loss management. Such approaches may not only improve clinical outcomes but also contribute to enhanced self-confidence, psychological well-being, and overall quality of life for individuals affected by baldness.

Assessment of the Phylogenetic Relationship of the Genus *Ocimum* with the Other Genera of the Family Lamiaceae

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ABSTRACT

The phylogenetic relationship between the genus *Ocimum* and other related genera within the family Lamiaceae was investigated using various DNA barcode markers. Lamiaceae is the largest family within the order Lamiales, comprising over 230 genera and more than 7,000 species, ranking sixth among all Angiosperm families. For this study, 13 distinct *Ocimum* varieties were collected from different states across India. DNA was extracted from each sample, followed by PCR amplification and sequencing. Phylogenetic analyses were conducted using MEGA 12 and MrBayes software. The Lamiaceae family has traditionally been considered closely related to the Verbenaceae. Our findings confirm that two plastid markers (*psbA–trnH* and *trnL–trnF*) along with one nuclear marker (*ITS*) are reliable DNA markers for species discrimination and phylogenetic reconstruction within this family. The genus *Ocimum* formed a well-supported monophyletic clade within the subfamily Neptoideae. These results indicate that the genus *Ocimum* is very closely related to other genera within the same subfamily and distantly related to other subfamilies within the family Lamiaceae.

Keywords: DNA barcode markers; Phylogenetic analysis; *Ocimum*; Lamiaceae.

Exploring miRNA-Mediated Regulation of HDAC4: A Potential Therapeutic Axis in Cardiac Failure

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ABSTRACT

Cardiac failure, or heart failure, is a pathophysiological condition marked by the heart's inefficiency to pump adequate amount of blood to meet the body's needs, primarily due to weakened or damaged cardiac muscle. Despite the availability of medications and lifestyle-based therapies aimed at alleviating symptoms and slowing disease progression, the discovery of rapidly effective pharmacological treatments remains a critical unmet need. Recent research has highlighted the cardioprotective role of a proteolytic fragment of histone deacetylase 4 (HDAC4), termed HDAC4-NT, which regulates the hexosamine biosynthetic pathway to mitigate heart failure. HDAC4, a nuclear transcriptional repressor, has been implicated in multiple cardiovascular pathologies when dysregulated. Concurrently, microRNAs (miRNAs) are emerging as key regulators of gene expression in both normal physiology and disease, including cardiac disorders. Several miRNAs, such as miR-1, miR-22, and miR-133, are known to influence HDAC4 expression and are integral to cardiac function. However, no miRNA has yet been identified that specifically regulates the cardioprotective HDAC4-NT fragment. This raises the hypothesis that certain miRNAs may modulate HDAC4-NT levels in cardiac tissue and play a previously unrecognized role in the development or prevention of cardiac failure. Investigating such miRNAs could open new avenues for therapeutic intervention as well as identifying potential biomarkers in heart failure.

Keywords: Cardiac Failure; HDAC4; microRNA

The Invisible Hunger: A Review on Hidden Hunger in Urban and Semi-Urban India Through Dietary Diversity

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ABSTRACT

Hidden hunger—micronutrient deficiency despite enough calories—affects 2 billion globally, with India heavily impacted. Urban and semi-urban areas now face rising cases due to poor dietary diversity and socio-economic shifts. As per the National Family Health Survey (NFHS-5, 2019–21), 57% of women (15–49 years) are anaemic, and 35.5% of urban under-five children are stunted. The Comprehensive National Nutrition Survey (CNNS, 2016–18) reports over 50% of children and adolescents are iron-deficient, with notable vitamin A deficiency.

Micronutrient deficiencies during key life stages such as pregnancy and adolescence can lead to lasting changes in gene expression through faulty DNA methylation. These epigenetic disruptions increase the risk of long-term health issues, including metabolic disorders, cognitive delays, and heart disease. In some individuals, reduced ability to process nutrients like folate and vitamin D—due to inherited variations—can worsen these effects, even when dietary intake or sun exposure appears adequate. This can result in elevated harmful compounds in the body and greater chances of developmental defects and deficiency-related complication.

Urban diets, though energy-dense, often lack bioavailable nutrients. The mean Individual Dietary Diversity Score (IDDS) in urban slums is <4/10. Diets are predominantly refined and processed, contributing to "functional hidden hunger."

This review underscores the urgent need for culturally appropriate, bioavailable, and genetically informed nutrition interventions to address the evolving burden of hidden hunger in India's urban and semi-urban contexts.

Keywords: Hidden Hunger**;** Genetic Polymorphism; Micronutrient Bioavailability**;** Nutrition Transition

Studies on Epidermal Anatomy of the Genus Sida L. (Malvaceae) at GGDC, Kaliganj Campus, Nadia, W.B.

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ABSTRACT

Macro and micro morphological studies of three *Sida* species, S. *acuta*, S. *cordata*, S. *rhombifolia* with special emphasis on epidermal anatomy were carried out and compared in order to determine the taxonomic relationship between them. The structure of epidermal cells and trichomes studied in detail for all the species from GGDC, Kaliganj campus. The results shows that stomata are anisocytic for all three species but the foliar trichomes of *Sida* possessed a remarkable diversity such as peltate. stellate forked stalked and capitate trichomes. Epidermal cells show significant diversity among species which are evident from the results. The studied attributes could be significant in differentiate the species which have pharmacognosical significance as *Sida* is a medicinally important genus. Additionally, it could also help in establishing the taxonomic relationship among species which could improve the present infra-generic classification of this genus.

Keywords: *Sida*; Epidermal anatomy; Trichomes.

Nanobionics Unleashed: Supercharging Plants for a Smarter Agricultural Future

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ABSTRACT

Nanobionics represents a cutting-edge fusion of biotechnology, nanotechnology, genetic engineering, robotics, and artificial intelligence, leading in a revolutionary era for modern agriculture. By integrating nano-sensors—such as carbon nanotubes—into plant tissues, crops can be endowed with "supernatural" abilities like real-time environmental sensing and communication. These intelligent systems convert biological responses into electrical signals, enabling advanced applications including drought detection, soil monitoring, and even glowing plants that function as living lamps. From smart dust tracking plant growth and microclimate shifts, to automated selfie-capturing plants, nanobionics blurs the line between biology and technology. As this field evolves, it promises to enhance plant productivity, sustainability, and human-plant interaction, offering transformative potential for global food security and ecological resilience.

Keywords: Nanotechnology; Nanobionics; Agriculture; Biosensor; AI

Male Brick Workers in North 24-Parganas District of West Bengal Show High Prevalence of Undernutrition and Anemia: A Cross-Sectional Study

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ABSTRACT

The study aimed to evaluate the nutritional and anemia status of male brick workers in North 24-Parganas, West Bengal, India. Seventy-two workers were randomly selected for this study. The nutritional status was evaluated from the reference values of body mass index (BMI) and mid-upper arm circumference (MUAC). For dietary assessment, we used the 24-hour recall method. Hemoglobin concentration and hematocrit value (HCT%) were measured, and the grade of anemia was assessed. Results showed that 34.5% were undernourished according to BMI and 40.12% according to MUAC. Additionally, 91.67% were anemic, with lower calorie, protein, vitamin, and mineral intake than recommended. Morphological alterations of red cells under light microscopy indicate microcytic anemia in brick kiln workers. The study found a significant link between socioeconomic status and nutritional measures. Overall, there is a high prevalence of undernutrition and anemia in these workers.

Keywords: Brick workers; Undernutrition; Anemia; Mid upper arm circumference

"Are Plastic containers, Canned Foods developing PCOS?" – A Systemic Review

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ABSTRACT

Today, one of the most prevalent endocrine disorders, affecting reproductive system of women is polycystic ovary syndrome (PCOS). PCOS refers as a metabolic and hormonal disorder involving multiple body systems. Person having PCOS fails to release ovum during ovulation due to hormonal imbalance which leads to anovulatory cycles, causing irregular menstrual cycle. Bisphenol A (BPA) is One of the factors that triggers PCOS. BPA is a chemical compound which is used in making plastic containers, water bottles, also found in epoxy resins that are used for coating inside the metals such as canned foods, water supply lines. Due to the similar structure of estrogen, BPA can bind to the estrogen receptor and activates the downstream pathways. some study confirmed that BPA suppresses GLUT4 expression resulting abnormal glucose metabolism by activating Aryl hydrocarbon receptor (AhR), a transcription factor which causes insulin resistance, a hallmark of PCOS. Though there is no certain "cure" of PCOS, but healthy lifestyle choices, balanced diet, proper monitoring can be helpful. To prevent the condition and have a healthy reproductive life BPA must be avoided. Canned food can be replaced with fresh whole foods like more fruits and vegetables. Instead of plastic containers other materials like glass, stainless steel can be a better choice. Heating the plastic containers can contaminate BPA in the food.

Keywords: PCOS; Bisphenol A; Insulin Resistance; Hormonal Imbalance

Purification and Characterization of Phosphate Dependent Glutaminase from Isolated Mitochondria of Sarcoma- 180 Tumour Cells

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ABSTRACT

Phosphate-dependent glutaminase purified to homogeneity from isolated mitochondria of Sarcoma 180 tumour cells. The enzyme was purified 113 fold over the original cell free extract with a specific activity of 125µM/mg protein. The enzyme had an Mr of 64 KD as judged by chromatography on DEAE Sepharose ion exchange and Sephacryl S-300 column cgromatography. Two major immunoreactive peptides of Mr values of 64000 and 56000 were found by immunoblot analysis using anti- (rat kidney glutaminase) antibodies. The activity of the purified tumour glutaminase was maximal at pH 8.0. The concentration dependence for both phosphate and glutamine were sigmoid when assayed at pH 8.0. Glutaminase enzyme from S-180 tumour gives its maximum activity at 100mM potassium phosphate buffer which corresponds with the phosphate dependence of glutaminase purified from EAC tumour cells. Glutamine concentration optima of the purified glutaminase is 0.2mM. The Km value of S-180 cell glutaminase enzyme is found to be low i.e. 0.83 than rat liver glutaminase (17mM).

Keywords: Glutaminase; S-180; Km; DEAE Sepharose

Macrophages in Streptozotocin-Induced Diabetic Mice: A Comprehensive Approach

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ABSTRACT

Streptozotocin (STZ) is hugely important for diabetes research. It targets pancreatic β-cells specifically. STZ gets into β-cells through GLUT-2 transporter and damages β-cells which induce hyperglycaemia. The doses of STZ of 50 and 60 mg/kg are responsible for persistent hyperglycaemia. The present study demonstrated the alteration of peritoneal macrophages, macrophages of liver and spleen cells, kidney cells in STZ induced mice. A significant percentage of peritoneal macrophages, liver macrophages, splenic cells and kidney cells became pyknotic and necrotic in STZ induced diabetic group. Increased macrophage aggregation and tendency of cell fusion was noticed in diabetic group which may induce inflammatory reaction. Cell viability was measured by trypan blue dye solution. Mean mortality index was significantly increased in peritoneal macrophages of diabetic group. Treatment with STZ caused central vein congestion and dilatation of sinusoidal spaces in H-E stained liver tissues. The results suggested that an imbalance of macrophage phenotypes contribute to impaired immune function in STZ-induced diabetic mice.

Keywords: Streptozotocin (STZ); Diabetes; Macrophages.

Tortoise Beetles (Cassidinae: Chrysomelidae): Their diversity, prevalence, and host preference in the forests of Dooars, West Bengal

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ABSTRACT

The present study aims to evaluate the faunal diversity of tortoise beetles in the forests of Dooars, West Bengal. A total of 23 species belonging to 7 genera across 2 tribes have been recorded. These species include *Aspidomorpha orientalis* Boheman, *Cassida stupa* Maulik, and *Cassida subtilis* Weise endemic to India, *Basiprionata maculipennis* (Boheman), *Cassida horni* Weise, *Cassida subtilis* Weise, *Cassida timefacta* Boheman, and *Laccoptera* nr. *discreta* Boheman, recorded for the first time in the state, with 73.91% of the reported species being new to the district. The genus *Aspidomorpha* exhibits the highest number of species, followed by *Cassida*. An analysis of their zoogeographical distribution indicates that the fauna, while predominantly Oriental (100%), also includes Nearctic and Australian elements (4.35% each) and Palaearctic elements (39.13%). Buxa Tiger Reserve demonstrates the highest species richness and abundance. Most species and individuals are encountered during the premonsoon period (February to May). It appears that plants from the Convolvulaceae family are the preferred choice for cassidines within the reserve. The feeding modes of tortoise beetles and the associated damage patterns are quite diverse and often species-specific. Further investigations into these aspects, along with the acquisition of new data regarding their food plants, will be crucial for both the taxonomy and phylogeny of beetles, as well as for the identification of agricultural and forest pests.

Keywords: Tortoise beetles; diversity; prevalence; host plant specificity; forests; Dooars; West Bengal.

Hemocytes of Cockroaches Sharing the Basic Function Like Phagocytosis and Cell Aggregation with Vertebrate PMNs, and Macrophages

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ABSTRACT

Hemocytes of invertebrates are the first line of defense against foreign molecules. In various insects, the hemocytes specially plasmatocytes and granulocytes represent cells with the typical functions i.e., glass adhesion with the pseudopodia, phagocytic capacity, aggregation, encapsulation, nodule formation and wound repair. Hemolymph was taken from the leg of *Periplaneta* sp. and stained by Giemsa, methylene blue (MB) and neutral red. Neutral red dye indicated the presence of lysosomal compartments. Increased cell aggregation, tendency of fusion of hemocytes and increased number of cytoplasmic process were noticed after exposure to yeast particles and charcoal particles when compared to hemocytes from cockroaches without exposure of foreign particles. Normal saline (0·9% NaCl) was injected into mice, rat peritoneum and the aspirate was taken for macrophage study. Both insects hemocytes and vertebrate macrophages showed glass adhesion with the pseudopodia, aggregation and different stages of phagocytosis. The results indicated the hemocytes shared the similarity of basic function like phagocytosis and cell aggregation with vertebrate professional phagocytes.

Keywords: Hemocytes; Macrophages; Phagocytosis; Adhesion.

Study of Hemocytes in Insects (Orthoptera) as Cutting-Edge Approach for Monitoring Ecosystem Health and Stability

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ABSTRACT

Ecosystem health, biodiversity levels, and resource availability have all been evaluated using indicator species. The adaptability and short lifespans make insects highly responsive to environmental changes and stress, making them ideal for monitoring ecosystem health. Hemocytes, the insect immune cells may provide good systems to evaluate environmental changes. Grasshopper (Orthoptera) species were collected during educational visit from adjacent areas of Tiger Trails resort located at Tala, which was buffer zone and close to Bandhavgarh National Park, Madhya Pradesh that was rich in biodiversity. Collection of grasshoppers were done along the existing tourist routes and forest rest houses. Hemolymph was smeared on glass slides and stained by Giemsa and neutral red. Activated charcoal particles in normal saline (0·67% NaCl) was used for phagocytosis study. Hemocytes showed normal cytomorphology and behaviour in this group. Significant presence of plasmatocytes and granulocytes was documented. Aggregation of granulocytes after charcoal particles injection was noted. Significant changes like cytoplasmic vacuolation, membrane rupture and blebbing were observed in the hemocytes of grasshoppers collected from different adjacent sites of agriculture fields of North 24 Parganas, West Bengal. The insects from N 24 Pgs agricultural fields may be exposed to insecticides, pesticides and others chemicals that may induce cell death. Present study will help to establish hemocytes an effective bio-indicator for screening health of the grassland ecosystem.

Keywords: Hemocytes; Environment; Cell Death; Bio-Indicator.

Analysis of Hemocytes from Freshwater Molluscs *Bellamya bengalensis* from Morali River, Nadia, West Bengal

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ABSTRACT

The Morali River is one of the rivers that flow through the Nadia district of West Bengal, India which is considered one of the "lost rivers" of Bengal whose loss is being documented to raise awareness about the environmental challenges. Hemocyte analysis of freshwater molluscs *Bellamya bengalensis* could be used as effective biomarkers for evaluation of environmental pollution. Freshwater molluscs *Bellamya bengalensis* were collected from site 1 of Morali River (Ballabhpur, Silinda – Darappur – Dudhpukur Rd) and site 2 of Morali River (near Morali bridge, Silinda – Darappur – Dudhpukur Rd, Hariankha, Nadia, West Bengal). Hemolymph was collected from *B. bengalensis* and hemocytes were stained by Giemsa, Leishmans Eosin Methylene blue solution, neutral red. Significant number of cells became pyknotic in site 1 group. Cellular aggregation on glass slides was found to be less in site 1 group when compared to site 2 group. Mean number of cells in each clump/ aggregate was also found to be less in site 1 specimens which may affect encapsulation and microaggregation. Hemocytes isolated from *Bellamya bengalensis* from site 1 showed neutral red (NR) positive response in their cytoplasm indicating lysosomal damage. The percentage of Trypan Blue (TB) positive cells represented a mortality index which was significantly increased in cells of site 1 group when compared to site 2 group (P value < 0.0001). Collection site 1 was associated with human habitats and human effluents may pollute the site and alter the environment of aquatic bodies rather than collection site 2. These environmental challenges may alter the morphology and behavior of hemocytes of molluscs. But comprehensive research is necessary to identify the bioindicators to address the environmental challenges.

Keywords: Hemocytes; Cell Aggregation; Freshwater Molluscs; Environmental Challenges.

Multidrug Resistance Nature of *Helicobacter pylori:* Special Focus on Immune-evasion Strategy

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ABSTRACT

Helicobacter pylori is a gram-negative, spiral-shaped bacterium that colonizes the human stomach and is closely linked to chronic gastritis, peptic ulcers, and gastric cancers such as adenocarcinoma and MALT lymphoma. Increasing antimicrobial resistance and immune evasion hinder effective treatment. Within the innate immune system, *H. pylori* modifies its lipopolysaccharide (LPS) to evade TLR4 recognition and alters flagellin to avoid TLR5 detection. It secretes virulence factors like VacA and γ-glutamyl transpeptidase (GGT) that suppress neutrophil ROS production, inhibit macrophage phagocytosis, and induce immune cell apoptosis. The bacterium also impairs dendritic cell maturation, resulting in ineffective T cell activation. In adaptive immunity, it downregulates MHC class II expression in antigen-presenting cells and promotes regulatory T cell (Treg) expansion by enhancing IL-10 and TGF-β production, thereby suppressing Th1 and Th17 responses. VacA further induces apoptosis in activated T cells, weakening host defense. Additionally, antigenic variation in outer membrane proteins allows evasion of antibody responses. These strategies enable persistent colonization, chronic inflammation, and disease progression. Understanding these mechanisms is vital for advancing vaccine development and improving therapeutic outcomes.

Keywords: *Helicobacter pylori,* Immune evasion strategy, Multidrug resistance, Peptic ulcer and gastritis

Selective Lethality of Novel Phyto-Insecticides Against Malarial Vector *Anopheles stephensi* and Change in Protein Content in Larval Tissue

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ABSTARCT

Integrated vector management is embattled for improving the target specificity, biocompatibility and sustainability of disease-vector control. Thus, the present study estimated the larvicidal activities of plant derived compound against the larvae of *Anopheles stephensi* under laboratory conditions. A change in larval protein content is documented with the use of phyto-insecticide derived from leaves of *Operculina turpethum* L. Bio-active fractions were pulled out from the leaves of the novel test-plant, after initial screening, by means of three different solvents viz. n-hexane, ethyl acetate, and absolute alcohol. Bioassays were performed against 3rd instars larvae of *Anopheles stephensi*. LC_{50} and LC_{90} values were determined through log-probit analyses. Data related to mortality was statistical justified through regression analysis. Effects on non-target organisms were assessed. Chemical personality of the pure compound was determined by infra-red spectroscopy. Change in larval protein content was tested after 72 h of exposure. Methanol extractive was the solvent of choice amongst all the solvent extractives. 100% mortality was exhibited by 3rd instars larvae. Dose-dependent mortality was established through regression analyses. The non-target populations were principally non-responsive to extract and pure compound under study.

Keywords: Phyto-insecticides; Mosquito; Larvicide; *Anopheles*

Urban Wetland Health Monitoring Through Zooplankton: A Comparative Real-Time Diversity Assessment Using Traditional and Carcass-Based Approaches in the Kolkata Metropolis

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ABSTRACT

Urban wetland conservation has emerged as a pressing issue in contemporary citizen science, given its role in carbon sequestration, groundwater recharge, heat regulation, and its potential contribution to a sustainable urban blue economy. Monitoring the ecological health of urban wetland is thus imperative. Metropolis like Kolkata, urban wetlands (primarily ponds) are typically isolated, fragmented, and non-interconnected lentic ecosystems. Despite these limitations, zooplankton continue to support aquatic biodiversity, including zooplankton communities. Zooplankton serve as bioindicators of water quality and ecological health with their diversity and abundance reflect pollution levels, nutrient status, and other ecosystem stressors. But, zooplankton monitoring in urban ponds of metropolis is limited. Thus, the present study aimed to evaluate the health of urban ponds by integrating traditional (TDA) and a novel carcass-based estimation (CE) approach to monitor real-time zooplankton dynamics. Fieldwork was conducted during the monsoon season of 2025 in selected ponds within the Khardah Municipality. Approximately 200 liters of water were sampled from each pond during evening hours. Live and carcass forms of zooplankton were differentiated using a staining protocol, and the density was calculated accordingly. Results revealed a consistent dominance of rotifers across all ponds, along with substantial inter-group variability. A total of three to five zooplankton groups were identified, with community composition varying based on pond-specific characteristics. Patterns of urban pond usage emerged as a significant factor influencing zooplankton assemblages. Notably, carcass analysis indicated a predominance of copepod carcasses over rotifer carcasses, suggesting potential predator-prey dynamics and episodic reproductive surges. Furthermore, spearman correlation revealed that total zooplankton diversity was positively correlated with pH, total dissolved solids (TDS), and electrical conductivity, while a negative correlation was observed with temperature, highlighting the sensitivity of zooplankton reproduction and growth to physicochemical factors. In summary, the urban ponds of Khardah exhibited low taxonomic diversity but high abundance of certain zooplankton groups, indicating a shift towards more tolerant species under urban environmental stress. However, further long-term studies are needed to assess species sustainability and ecosystem resilience within these closed urban wetland systems.

Keywords: zooplankton, urban ponds, carcass, water quality, wetland, Kolkata Metropolis

Extraordinary Concealment of the Praying Mantis (Insecta: Mantodea) Documented in the Forested and Urban Landscapes of West Bengal, India

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ABSTRACT

Praying mantises demonstrate exceptional abilities in camouflage and mimicry, allowing them to blend into their surroundings and avoid potential dangers. When confronted with threats, these insects may exhibit warning colours or engage in various defensive behaviours. This form of communication underscores the remarkable variety of disguises utilized by praying mantises in both forested and urban regions of West Bengal, as well as their increasing distribution. The study identified eight mantid species across eight genera, categorized into three families and five subfamilies. The family Mantidae was the most prevalent, representing 36% of the findings, with three species across three genera: *Statilia maculata* (Thunberg) (Asian Jumping Mantis), *Hierodula patellifera* (Audinet-Serville), and *Mantis religiosa inornata* Werner (European Mantis). Among these, *Statilia maculata* was identified as the most common and dominant species in the study area, with peak observations noted during the post-monsoon season. Significantly, *Amantis reticulata* (Haan) was recorded for the first time in the state, and all eight species were newly documented in the protected forests of Alipurduar district and the urban environments of North 24 Parganas district in West Bengal. *Odontomantis planiceps* Haan, known as the Asian Ant Mantis, was found exclusively in North 24 Parganas, inhabiting ant colonies. This small mantis exhibits Batesian mimicry in its juvenile stages, resembling a black ant. Moreover, *Ambivia undata* (Fabricius) (Asian Twig Mimicking Mantis) has a cryptic appearance that mimics the texture and colour of tree bark, enabling it to ambush prey while remaining unnoticed by both predators and prey. Additionally, *Euclimacia nodosa* (Westwood), a rare and poorly understood species of mantidfly (Mantispidae: Neuroptera), was collected and is recognized for its mimicry of social wasps in body shape and coloration, featuring raptorial forelegs similar to those of mantises. This survey enhances the existing knowledge regarding the variety of mantis camouflage in the region and will assist in formulating conservation management strategies, utilizing mantises as indicators of biodiversity.

Keywords: Camouflage; mimicry; diversity; mantis; forested; urban areas; North 24 Parganas; West Bengal.

Dose Dependent Effects of Glyphosate on Cell Morphology and Hemocyte Counts in *Lamellidens marginalis*

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ABSTRACT

Lamellidens marginalis, a freshwater bivalve prevalent throughout the Indian subcontinent, plays a crucial role as a bioindicator in aquatic ecosystems. The hemolymph of bivalves is particularly valuable for evaluating toxicity levels in water bodies affected by chemical pollutants. This study examines the alterations in hemocytes and the cytotoxic effects on *L. marginalis* following sublethal exposure to glyphosate ammonium salt, a widely utilized broad-spectrum herbicide. Specimens were subjected to two concentrations (0.3 g/L and 3 g/L) of glyphosate over periods of 3, 5, and 7 days. Hemolymph samples were assessed for total hemocyte count (THC), differential hemocyte count (DHC), and cellular morphology through Giemsa staining. The findings revealed a concentration- and time-dependent increase in THC, indicating a stress-related immunological response. DHC analysis showed a reduction in blast-like cells and hyalinocytes, alongside a significant increase in granulocytes, particularly at the higher concentration. Notable morphological changes, including vacuolization, nuclear fragmentation, membrane rupture, binucleation, and chromatin marginalization, were observed in hemocytes from the treated groups. Granulocytes emerged as the predominant and most morphologically altered cell type under stress, underscoring their essential role in immune defense and detoxification. These results suggest that glyphosate exposure can compromise the immune system of freshwater mussels, potentially increasing their susceptibility to pollution and disease, which may have broader implications for the health of freshwater ecosystems.

Keywords: Bivalve; Glyphosate; Hemocytes; Cytotoxicity

A Study on Endosymbiotic Mites and Ciliates Associated with the Unionid Mussel, *Lamellidens marginalis*

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ABSTRACT

The present study investigates the endosymbiotic associations between the freshwater mussel *Lamellidens marginalis* and two symbionts: water mites (*Unionicola* spp.) and ciliates (*Conchophthirus* spp.). Mussel specimens were collected from Banipur, Habra, West Bengal, India between August 2024 and March 2025, and examined for prevalence, anatomical localization, and morphological diversity of the associated symbionts. Water mites showed a high overall prevalence of 71.8%, with seasonal peaks observed in late summer (August) and early spring (February), suggesting temperature-dependent infestation patterns. Microscopic observations revealed distinct sexual dimorphism and various life stages of *Unionicola*, including egg, larvae and adult forms, along with tissue nodulation and occasional pearl formation in heavily infested hosts. In contrast, *Conchophthirus* spp., mainly *C. lamellidens* and *C. acuminatus*, were observed within gill filaments, exhibiting moderate seasonal prevalence, with a peak in winter (January). While mites appeared to be parasitic, sometimes damaging host tissues and reproductive structures, the ciliates seemed largely commensal, although heavy infestations could impair gill function. This study highlights the complex and dynamic nature of host-symbiont interactions in freshwater ecosystems. The findings underscore the ecological role of *L. marginalis* as both a host and a bioindicator.

Keywords: Mussel; Endosymbiont; Prevalence; Pathology

Diversity of Symbiotic Flagellates Isolated from Hindgut of *Coptotermes* and Investigation on the Impact of Metronidazole

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ABSTRACT

Coptotermes sp. is a lower termite that hosts protist flagellates in its hindgut, which play a crucial role in the digestion of lignocelluloses, a primary component of wood. This study focused on identifying, characterizing, and assessing the diversity of these symbiotic flagellates, as well as examining the impact of metronidazole, an antiprotozoal drug on their populations. Termites were collected from residential areas in Kolkata and dissected in 0.4% normal saline to obtain hindgut contents. Smears were prepared and stained using Delafield and Heidenhain's hematoxylin method after fixation. The flagellates were identified based on morphological characteristics and taxonomic keys, with micrometric measurements taken. Metronidazole was administered separately at four different concentrations (0.04 gm/ml, 0.02 gm/ml, 0.01 gm/ml, and 0.005 gm/ml) to termite colonies maintained in controlled condition. After 24, 72, 96, and 120 hours post-treatment, the termites were extracted, and the flagellate populations in their guts were quantified using a Hemocytometer. Four major genera of flagellates were identified: *Pseudotrichonympha*, *Holomastigote*, *Holomastogotoides*, and *Spirotrichonympha*, with six species under the genus *Pseudotrichonympha* (*P. subapicalis*, *P. cardiformis*, *P. indica*, *P. pisciformis*, *P. belari*, and *P. hertwigi*) and three species under *Holomastogotoides* (*H. rayi*, *H. sphaeroidalis*, and *H. indica*). Metronidazole treatment indicated a dose-dependent reduction in flagellate density, with higher concentrations leading to increased mortality rates compared to lower concentrations and the control group.

Keywords: *Coptotermes;* Symbiotic flagellates; Morphology; Metronidazole.

A Preliminary Study on Physiological Effects of Arsenic (Iii) Exposure in Some Organs of Tilapia (*Oreochromis niloticus)*

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ABSTRACT

In recent times arsenic has become a major public health concern due to its widespread occurrence and carcinogenicity. Various compounds of arsenic like Arsenic trichloride ($AsCl_3$) are used in the production of organo-arsenic compounds for pharmaceuticals and pesticides industries that can pollute our waterbodies. Dietary and waterborne exposure to heavy metals causes accumulation in fish tissues which have been subsequently linked to toxic effects. Consumption of arsenic-contaminated fish is an important exposure pathway for human. The present study aims to investigate the histopathological and physiological effects of arsenic (III) in exposed Tilapia. *Oreochromis niloticus*(7cm -8cm) were exposed to arsenic chloride over a period of time, 5 – 15 days, and liver, ovarian and testes were harvested for histological and biochemical analyses. It was observed that arsenic (III) treatment caused significant histopathological changes like cloudy swelling, focal necrosis, vacuolization and congestion in liver tissues and enzymes like Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST) levels were also found to be elevated. Testicular tissues showed tissue fragmentation and fibrosis and ovarian tissue showed rupturing and detachment of follicular basement, cytoplasmic vacuolization and structural deterioration of follicles. Testosterone and oestradiol hormone levels estimated through elisa showed a decrease in arsenic exposed fishes. Thus, arsenic trichloride exposure caused significant histopathological and biochemical damage in liver and gonads of exposed Tilapia.

Keywords: arsenic; tilapia; liver; gonads

Nanobodies: Nature's Small Wonders that Could Change Therapeutics.

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ABSTRACT

Nanobodies, or single-domain antibodies, represent a unique class of antigen-binding fragments derived from the heavy-chain-only antibodies naturally found in camelids and sharks. With small size (~15 kDa), high stability, and strong affinity, nanobodies have become invaluable tools in both biomedical research and therapeutic applications. Unlike conventional antibodies, their compact structure enables access to cryptic or concave epitopes, making them ideal for targeting challenging molecular structures such as viral proteins, ion channels, and intracellular antigens. Their efficient production in microbial systems, low immunogenicity, and ease of modular engineering further enhance their versatility. Recent advancements highlight their therapeutic potential in oncology, neurodegenerative disorders and infectious diseases. In imaging and diagnostics, nanobodies offer superior tissue penetration and rapid systemic clearance, yielding high-contrast visualization. Additionally, their ability to be fused with various functional domains expands their potential as multifunctional therapeutic agents. As biopharmaceutical interest in targeted, efficient, and cost-effective therapeutics grows, nanobodies are poised to play a pivotal role in next-generation drug development and precision medicine.

Keywords: Nanobodies; single-domain antibodies; biopharmaceuticals; therapeutics.

Direct Transcriptional Regulation of Nrf2 by HIF-1α Under Hypoxic Stimulation in HepG2 Cancer Cells

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ABSTRACT

Hypoxic conditions are generally characterized by insufficient oxygen supply which is a characteristic feature in the tumor-microenvironment (TME) of solid tumors and such conditions tend to generate higher reactive oxygen species (ROS) level. However, cancer cells adapt to variable oxygen availability. The key regulators of cellular response to hypoxic and oxidative stress are hypoxia inducible-factors (HIFs) and nuclear-factor-erythroid-2-related-factor-2 (NRF2) respectively. Together HIFs and NRF2 invigilate and promote cancer cells to adapt and survive under hypoxic condition. Additionally oxidative stress and hypoxia in the TME are intricately connected contributing to a remarkably complex interaction between NRF2 and HIF.

This study is focused to clarify different dynamics of the NRF2 - HIF-1α network, under hypoxic condition. We studied the expressional pattern of HIF-1α and NRF2 and their downstream target genes at variable time points following hypoxic stimulation in the hepatocellular cancer cells. HIF-1α binding site in the Nrf2 promoter was found by Contra V2 software and validated this binding through ChIP assay. Moreover, Mutation of the HIF-1α binding site within Nrf2 promoter resulted in significant reduction in the promoter activity as evident in the dual luciferase assay. To our knowledge, this is the first study demonstrating direct transcriptional regulation of Nrf2 by HIF-1α to examine tangled reciprocity between NRF2 and HIF-1α.

Keywords: Hypoxia; Oxidative stress; HIF-1α; NRF2.

Mycobacterium tuberculosis: Humanity's Deadly Microbial Foe

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ABSTRACT

Mycobacterium tuberculosis is the causative agent of tuberculosis with global concern affecting the humanity since ancient civilization with its deadly pathogenesis. Tuberculosis has become a global health risk. Though the number of TB cases is decreasing worldwide still our country has a great contribution to the global TB burden. This paper provides an in-depth overview on some unique biology and adaptations of *Mycobacterium tuberculosis* which make it formidable such as thick waxy cell wall, ability to manipulate host immune system, capacity to remain dormant with intracellular survival, granuloma formation and drug resistance. The pathogen is called "Great Manipulator" as it can evade host immunity and metabolic pathways and antibiotics also. *Mycobacterium* can modulate various cell signalling pathway to alter the cytokines production aiding to escape from microbicidal actions. These make the pathogen challenging to treat.

Keywords: *Mycobacterium;* Granuloma; Immune evasion; Drug resistance.

Alarming Rise of Early-Onset Myocardial Infarction and Cardiac Arrest on the backdrop of COVID-19 Pandemic: Risk Factors, Post Pandemic Trends, and Future Directions

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ABSTRACT

Recent years have been witnessing a surge in the incidence of Myocardial Infraction (MI) and Cardiac Arrest (CA) in young adults under 45 years, that were conventionally encountered in older age groups. This shift in risk dynamics is due to many contributing factors like stressful, modern, sedentary lifestyle, obesity, smoking, dyslipidemia, genetic predisposition etc. Post SARS-CoV-2 infection following the Covid-19 pandemic cardiovascular complexities manifested itself in a larger scale in the form of myocarditis, cardiovascular dysfunction, complex inflammatory responses, owing to delay in health check ups, mental depression, disrupted daily routines etc. all culminating in increased cardiovascular risks. Potential linking of cardiovascular side effects to certain Covid-19 vaccines is also under active investigation and cannot be ruled out. This study evaluates the emerging epidemiological trends, crucial roles of multifactorial contributors and the targeted prevention strategies that might help in cardiovascular risk stratification and early screening ensuring significant recovery. Addressing both long standing & new risk factors is crucial to reversing this trend and restoring cardiovascular health in young adults.

Keywords: Myocardial Infraction; Cardiac Arrest; SARS-CoV-2; Risk Dynamics

Precision Parenthood: CRISPR-Cas9 for Artificial Reproductive Techniques

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ABSTRACT

Genome editing based on site-directed nucleases using CRISPR/Cas9, grease efficient genetic variations in human embryos. In this sphere, Researchers are concentrating on refining supported reproductive styles and conducting germ cell editing. CRISPR/ Cas9 technology represents a redoubtable tool for genomic and epigenomic manipulation within oocytes and early embryos. The establishment of oversight mechanisms specific to CRISPR, guarantees the responsible and ethical use of this important technology. Despite the perceived aptness of reproductive medicines for treating gestation, it is delicate to justify germline genome editing. Regarding mitochondrial donation, the fore-stallment of inheritable complaint in offspring by genome editing might be respectable in limited cases of serious or life-hanging conditions, where no indispensable medicine is available. Nevertheless, the mosaicism bolstering mortal embryos as well as the off-target effect by artificial nucleases will presumably hamper preimplantation inheritable opinion (PGD) previous to embryo transfer. Still, the clinical misgivings emphasize the need for embryology that can answer questions regarding germline aneuploidy and mosaicism using genome editing. The use of germline genome editing seems compelling life hanging autosomal inheritable diseases, similar as autosomal dominant conditions (Huntington complaint) or autosomal sleepish conditions (Cystic fibrosis). In contributing to the ongoing converse, this review aims to inform and guide the responsible and effective operation of CRISPR in the dynamic field of reproductive biology.

Keywords: CRISPR/CAS9; Germline modification; PGD; Genome editing.

Morpho-molecular Based Detection and Haematological Profiling of Canine Babesiosis: A Kolkata Based Study

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ABSTRACT

Canine Babesiosis is a significant tick-borne haemoprotozoan disease impacting dog health globally. This study aimed to detect *Babesia spp*. infection in dogs using both morpho-molecular approaches—specifically, microscopic examination of stained blood smears and tetra-primer PCR assay—and to assess the haematological alterations in PCR-positive cases. Blood samples were collected from dogs in and around Kolkata, West Bengal, and examined microscopically for the presence of Babesia parasites. Molecular detection was carried out using a tetra-primer PCR technique, which demonstrated enhanced sensitivity and specificity compared to traditional microscopy. Haematological profiling revealed marked alterations in infected dogs, including anaemia, thrombocytopenia, and leukocytosis, consistent with the clinical manifestations of babesiosis. The combined use of molecular and microscopic diagnostics provided a comprehensive detection strategy. In conclusion, this study underscores the value of integrating morpho-molecular tools for accurate and early diagnosis of canine babesiosis, enabling better disease management. The findings have broader implications for veterinary diagnostics, public health, and the prevention of zoonotic transmission.

Keywords: *Babesia* sp.; Tetra-primer PCR; Microscopy; haematological profiling.

The Vanishing Krait: How the Decline of *Bungarus fasciatus* and Rise of *Daboia russelii* (Russell's viper) Are Fuelling a Snakebite Crisis in West Bengal

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ABSTRACT

West Bengal is presently experiencing a nuanced yet significant ecological transformation in its venomous snake population, characterised by a decrease in ***Bungarus fasciatus*** (kraits) and a simultaneous increase in viper species, notably ***Daboia russelii*** (Russell's viper). Although both species possess significant venom, this alteration transcends mere taxonomic issues; it is evolving into a public health emergency. In contrast to kraits, which are nocturnal, reclusive, and less aggressive, *Daboia* species exhibit diurnal behaviour, territoriality, and a greater propensity to strike in human-inhabited environments. Consequently, the total incidence of snakebite cases has risen markedly, particularly during daylight hours and agricultural endeavours. Historically, *Bungarus* has had a stabilising function within the local environment, cohabiting alongside people for ages while exhibiting a relatively low incidence of bites owing to its elusive nature. The reduction of kraits—potentially attributable to environmental deterioration, pesticide use, and habitat destruction—is disrupting this ecological equilibrium and facilitating the proliferation of more aggressive *Daboia* species. The increasing ineffectiveness of polyvalent anti-venoms against regional *Daboia* venoms exacerbates the issue, rendering therapy more difficult and less dependable. This article advocates for an immediate ecological and public health response focused on the restoration and conservation of *Bungarus* populations. Re-establishing the natural dominance of kraits in their indigenous habitats may mitigate human-snake conflict and decrease overall envenomation incidents. The research underscores the significance of habitat conservation, ecological rehabilitation, and venom-specific investigations as enduring measures for restoring snake populations and alleviating snakebite-associated health issues in West Bengal.

Impact of Heavy Metal Pollution on Reproduction of Tilapia: An Indispensable Perception for Understanding Sustainable Development Goals

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ABSTRACT

Fish and fishery economy play a pivotal role in global sustenance and economic stability. Understanding the impact of heavy metal toxicity on Tilapia reproduction is imperative for achieving the Sustainable Development Goals (SDGs). Numerous water bodies (bheri) located in North 24 Parganas, are grappling with substantial environmental contamination. The pollution in this region stems from diverse industrial, sewage and agricultural activities prevalent in the area. Consequently, investigating the contamination of fish with heavy metals becomes imperative for the well-being of populace in a country surrounded by water bodies. This study aims to ascertain and compare the concentrations of heavy metals (Cadmium, Lead, Mercury, Copper) in water samples and its effect on reproduction of tilapia. The samples were categorized into two groups: one from polluted water bodies (intoxicated group) and other from uncontaminated water bodies (control group). The results revealed a noteworthy disparity between the intoxicated group and the control group. The histological examination of fish organs was documented. In the testes of the intoxicated group, degenerative changes and a reduced number of seminiferous tubules were observed. The ovaries exhibited deformities in their normal shapes, and severe lymphocytic infiltration, and the brain displayed neuronal degeneration along with a significant loss of granular cells. Hence, our present investigation aims to raise awareness within communities regarding the environmental pollution affecting edible aquatic organisms.

Keywords: Pollution; heavy metal; histopathology; reproduction.

Management of Phtophagous Mites Infesting Medicinal Plants of Sundarban with Biopesticides Including Green Pesticides and Entomopathogenic Fungi

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ABSTRACT

Sundarbans, famous for its rich biodiversity of plants including, variety of Medicinal and Aromatic plants (MAP) along with mangrove plants, all of which contributes to its unique ecosystem are under the threat from various pests including mites. Management of mites with chemical pesticide is effective but, indiscriminate use of chemical pesticides for controlling pest of Medicinal plants are not environment friendly and, in many cases, the predatory mites which are present as natural enemies are also eliminated causing influx of pest problem. In this point of view, use of biopesticides including green pesticides and entomopathogenic fungi which are ecofriendly in nature can reduce the chemical hazards and save Medicinal plants from mite infestation. For the bio control experiments a continuous stock culture of Brevipalpus mitrofanovi mites on Justicia adhatoda leaves has been maintained in rearing tray throughout the period of experiment in an incubator at 25±2ºC and 70-75% relative humidity (RH). Methanolic extracts of Aswagandha (ALE), Nishinda (NLE), Ramtulsi (RLE) leaves were applied for evaluation as green pesticides. Conidial spore suspensions of three different EPF viz. Beauveria bassiana, Paeciolomyces fumosoroseus and Metarhizium anisopilae were applied as to evaluate the acaricidal potential. The laboratory bioassays were done with different concentrations of plant extracts and EPF at 27±2ºC and 70-75% RH under laboratory condition. For the green pesticide, applications of NLE, ALE and RLE were used and every extract in all the concentrations has shown acaricidal efficacy with high percentage of population mortality. NLE shows highest percentage mean mortality in all the concentrations including minimum LC50 (1.169 mg/ml) and LT50 (1.74 days) value in comparison to other green pesticides. In case of applications of EPF, B. bassiana shown highest mean mortality in all the concentrations with minimum LC50 value (2.16×10^6 conidial spores/ml) and the LT50 (2.12days). The present study confers that all the green pesticide (NLE, ALE, RLE) and EPF (Bb, Pl, Mt) has shown good efficacy as potential eco-friendly acaricides. This study will be helpful in the application of green pesticides and entomopathogenic fungi for broad spectrum management of plant mites in a judicious manner.

Key words: Phytophagous mites; botanical pesticides; EPF; Sundarbans

Reviving the Marali: A Decade of Student-Led River Rejuvenation and Biodiversity Monitoring at Hingnara Anchal Public Institution

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ABSTRACT

The Marali River, once a lifeline for the local ecosystem near Hingnara Anchal Public Institution, West Bengal, is now on the brink of extinction due to climate change, altered land-use patterns, and unchecked human interference. Since 2014, under my mentorship as a biology teacher, students of our school have been actively engaged in the revival of this dying horseshoe-shaped river through field studies, awareness programs, and sustainable innovations. Seasonal and annual changes in plankton communities, ichthyofaunal diversity, macrophytes, and other flora and fauna have been recorded during pre- and post-monsoon periods, highlighting significant ecological shifts. The morphology and direction of the river have also altered over time. Basic physicochemical parameters such as DO, turbidity, total hardness, and alkalinity are being monitored using school-level facilities. Students have initiated low-cost eco-solutions like utilizing nutrient-rich jute-retting water for vertical farming and converting invasive water hyacinth into fertilizer. This project not only promotes biodiversity restoration but also integrates practical learning and community involvement. Collaboration with NGOs and governmental bodies is ongoing to seek broader support and recognition. While qualitative biodiversity data have been collected, there is a pressing need for more advanced, quantitative, and laboratory-based analyses to further enhance this grassroots river rejuvenation effort. This initiative highlights the vital role of student-led, school-based research in addressing real-world environmental crises and inspiring community-driven conservation.

Keywords: River Rejuvenation; Biodiversity Monitoring; Student-Led Conservation; Land-Use and Climate Impact

Chlorpyrifos Pesticide Contamination in Agricultural Ponds of Mathurapur-II Block, South 24 Parganas: Survey and Water Analysis-Based Risk Assessment for *Amblypharyngodon mola*

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ABSTRACT

This study investigates the presence of chlorpyrifos in agricultural ponds of Mathurapur-II block, South 24 Parganas, and evaluates potential toxicological risks to the indigenous fish *Amblypharyngodon mola*. Through farmer surveys and GPS-mapped sampling, widespread use of chlorpyrifos-based pesticides (e.g., Strike, Toofan, Action-505) was confirmed. GC analysis revealed chlorpyrifos concentrations ranging from 0.012 to 0.024 ppm in pond water. Supporting physico-chemical parameters showed moderately alkaline pH and elevated phosphate levels. Acute toxicity bioassays (96-hour LC_{50}) and sublethal exposure studies will be conducted to assess impacts on fish health and behaviour. The findings highlight the contamination risks in small-scale aquaculture systems due to pesticide runoff.

Keywords: Chlorpyrifos; *Amblypharyngodon mola;* Agricultural ponds; Toxicity

Role of Guppy Fish (*Poecilia reticulata,* Family: Poeciliidae) to Combat Vector-Borne Diseases in West Bengal, India

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ABSTRACT

Vector borne diseases, especially mosquito borne diseases, are one of the major problems of human health throughout the globe. Dengue, Chikungunya, Malaria & Japanese Encephalitis are the major mosquito borne diseases in West Bengal. Filariasis is found in some parts of our state. These mosquito borne diseases can be fatal but preventable. Mosquitoes are well-known vectors for Zika virus and West Nile virus. To prevent the vector borne diseases we need to deal with the source (vector) and 'Kill them at the source'. There are three major processes to control mosquito larvae, namely, (i) environmental management**;** (ii) biological management; (iii) chemical management. Guppy fishes are well known to consume mosquito larvae and an effective, environment friendly agent for controlling mosquito populations. The government of West Bengal released guppy fish (*Poecilia reticulata*) in water bodies to control vector-borne diseases, particularly dengue, by targeting mosquito larvae. This biological control method is being implemented through the State Fisheries Department in collaboration with local bodies and self-help groups which found significant success in reducing mosquito populations and disease transmission. The usefulness of larvivorous fishes especially Guppy and *Gambusia* in mosquito control operations in different situations has been proved successful throughout the globe. In most of the urban areas, a little attention has been paid towards the development of larvivorous fish resources and its operational mechanism.

Keywords: Mosquito borne diseases; larvivorous fish; biological control; guppy fish

Bioaccumulation of Chromium in Mud Crab (*Scylla serrata*) Collected from Digha Coast, West Bengal, India

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ABSTRACT

Now-a-days, heavy metal pollution is one of the major concerns in coastal areas. Due to industrialization, urbanization and rapid agricultural practices, heavy metal levels have been increased day by day and thus causing problems to the inhabitants of the particular water bodies. Chromium is one of the most common heavy metal in the environment known to use in several industries and other commercial purposes. Mud crab (*Scylla serrata*) is one of the potential and high value crustaceans that are abundant in the muddy bottom of estuary of river Subarnarekha of Digha coast. It was known that chromium enters the body of the crab, disrupts the enzymatic function and deform the tissue structure. Following the observation, the present study aimed to measure the level of both total chromium and hexavalent chromium [Cr (VI)] in selective tissue of *Scylla serrata*, namely, gill, hepatopancreas and chelate muscle in the studied area in respect of suitable control. The concentration of chromium in crab tissues were determined using Atomic Absorption Spectroscopy (AAS) (Model ICE 3300) and hexavalent chromium was measured using UV-Spectrophotometer following APHA (2012). It was found that the chromium level [both total Chromium and Hexavalent chromium] in different tissues of mud crab examined was significantly higher ($p<0.05$ to 0.001) than the control. The implication of study will be discussed.

Keywords: Coastal pollution; Total chromium; hexavalent chromium; Mud crab; heavy metals.

Karonda (Carissa carandas L.) - A Nutraceutical Fruit for Medicinal and Health Benefits

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ABSTRACT

Carissa carandas L., an ethno-medicinally important plant, belongs to the family Apocynaceae and is an evergreen shrub. Its fruit has been used in many ethnomedicines as stomachic, anti-diarrheal, anti-inflammatory, antioxidant, antidiabetic, antiviral, antipyretic, and cardiotonic activities. The present study was designed to evaluate the nutraceutical potential and antioxidant activity of the fruits. The antioxidant activity was evaluated by using 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay, and the IC50 value of the methanolic extract of *C. carandas* was found to be 70.16 ±4.71µg/ml. Among the nutraceutical properties, carbohydrate (30.11 ± 0.45 mg/g), starch (174.56 ± 2.39mg/g), protein (0.128 ± 0.001µg/g), total phenolic content 270±2.68 (mg GAE/g dw), and total Flavonoids Content (123.5±1.32 ± mg RUE/g dw) were recorded. The result shows that *C. carandas* has a high nutraceutical value. The study has revealed that the fruits can be used as a dietary supplement as well as a therapeutic agent, as they would exert several beneficial effects by virtue of their antioxidant activity.

Keywords: *Carissa carandas*, Ethnomedicine, Antioxidant, Nutraceutical

Bright Future for Fresh Produce: How Hydrogen Sulfide and Blue Light Revolutionize Pepper Preservation

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ABSTRACT

The rapid ripening of fruits after harvest poses a major challenge for food waste and supply chains. Our innovative research unveils a powerful dual strategy to significantly extend the shelf-life of pepper (*Capsicum annuum* L.) fruit, which has a high economic and nutritional value. In our study, harvested pepper fruits were treated with a 1 mM NaHS solution (donor of H_2S) and then stored under blue light for 7 days at RT (25°C). This innovative treatment proved remarkably effective, dramatically slowing down decay, minimizing weight loss, and maintaining fruit firmness, color, and respiration rate. Beyond these visible benefits, the H_2S + BL combination actively maintained postharvest photosynthesis through malic acid metabolism by NADP-ME malic enzyme. The treatment was also found effective in the regulation of anthocyanin, photochemical and thermal quenching. Crucially, it supported the fruit's natural defences, boosting endogenous H_2S and higher activity of its biosynthesis-associated enzymes such as D-cysteine desulfhydrase (DCD) and L-cysteine desulfhydrase (LCD) and significantly reducing reactive oxygen species and enhancing antioxidants. The delayed ripening under H_2S + BL was corroborated with higher cell viability and minimized loss of DNA. This pioneering work demonstrates that the synergistic application of H_2S and blue light offers a sustainable and highly effective method to delay senescence in pepper fruit, promising a future with less food waste and enhanced post-harvest quality.

Keywords: Fruit ripening; Shelf-life; Reactive oxygen species; Postharvest

Putrescine-Doped ZnO Nanoentities Regulate Ethylene Signaling, Chloroplast Ultrastructure, and Stress Response Mechanisms in Drought-Stressed Rice

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ABSTRACT

A recent experiment demonstrated the roles of polyamine (PA) applied exogenously to recover the drought stress (DS) tolerance in cereal crops. However, PAs in combination with metallic nanoparticles are not well suited to monitor the improved effects on plant tolerance under DS. We reported putrescine (PUT)-doped synthesis of zinc-oxide nanoparticles through biochemical methods for effective response in different drought-sensitive characters of plants, improving tolerance. Thus, 14-day-old seedlings of rice (*Oryza sativa* L. cv. Swarna Sub1) were subjected to foliar application of PUT, both individually and in combination with putrescine-doped zinc oxide nanoparticles (PUT-nZnO), under DS induced by 12% polyethylene glycol (PEG). The study assessed key physiological and molecular parameters, including growth attributes, thermographic profiling, chloroplast ultrastructure, polyamine (PA) and ethylene signaling, cell death, redox metabolism, and nuclear integrity to evaluate stress mitigation. The results revealed that PUT-nZnO treatment notably enhanced membrane stability, minimized DNA degradation, restored ion homeostasis through ATP hydrolysis, and preserved cellular structure and viability. It also modulated oxidative signaling and enhanced antioxidant defenses, effectively reducing drought-induced injury at the early seedling stage. Future directions include molecular dissection of downstream signaling networks activated by PUT-nZnO to uncover long-term effects on plant stress memory and resilience. Moreover, the incorporation of such nano-enabled formulations into agronomic practices offers promising potential for the development of sustainable, climate-resilient agriculture.

Keywords: Canopy Temperature; Cell death; Nuclear integrity; Water deficit

The Neuro-Chemical Perspective of Happiness and Pleasure

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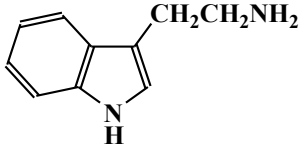
ABSTRACT

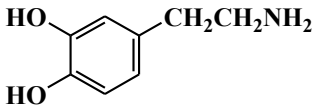
Happiness involves a range of 'positive' feelings such as joy, well-being, and an overall sense of contentment. These positive feelings are often associated with positive life experiences such as spending time with loved ones, getting engaged in enjoyable activities, achieving life goals, etc. Happiness is something which arises spontaneously 'from within'.

Pleasure is a 'feel-good' experience associated with enjoyment. Happiness and pleasure are not synonymous. The evolutionary drive for survival and reproduction, and the rewards associated with them, control the actions of the animal kingdom. According to our understanding of the animal kingdom, humans are the only creatures that can consciously experience pleasure and happiness (although the latter is elusive). The link between pleasure and happiness has a long history in psychology. Sigmund Freud wrote that people 'strive after happiness; they want to become happy and to remain so'. This tendency aims to alleviate pain and displeasure and maximize the feelings of pleasure.

Researchers have identified many networks of brain regions and neurotransmitters responsible for the feeling of pleasure and happiness. As mentioned earlier, happiness and pleasure are not synonymous. Still, the neurotransmitters responsible for these emotions are collectively called the happiness agents (or happy hormones). The two most important happy hormones are serotonin and dopamine.



Serotonin



Dopamine

Keywords: Life-experiences, Happy-hormones, Neuro-chemicals

The Science Behind Brown Rice: Milling Processes and Health Perspectives

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ABSTRACT

Brown rice is a whole grain that preserves the bran and germ layers, has emerged as a nutritionally dense alternative to refined white rice. Its consumption is increasingly advocated in light of the global rise in non-communicable diseases and nutrient-deficient diets. This paper synthesizes scientific evidence on the post-harvest processing (milling) of brown rice and evaluates its nutritional composition and health benefits. A comparative approach is used to highlight differences between brown and white rice, focusing on the role of dehusking and the preservation of nutrient-rich layers during milling. The dehusking process removes only the inedible husk, preserving the bran and germ, which contain dietary fiber, B vitamins, essential minerals, and antioxidants. Consumption of brown rice is associated with improved glycemic control, cardiovascular health, digestive function, and weight management. Despite these benefits, barriers such as shorter shelf life, longer cooking time, and consumer preference for refined grains limit its adoption. Brown rice offers significant potential as a functional food in promoting public health and preventing chronic disease. Greater integration of brown rice into dietary patterns can be achieved through improved processing technologies, public education, and supportive nutrition policies. Understanding its milling process is key to preserving its nutritional value and advocating for its broader consumption.

Keywords: Brown rice; Milling process; Nutrition; Chronic disease prevention.

Exploring The Antimicrobial Potential of Banana Blossom Extracts

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ABSTRACT

Bananas are a common fruit crop and the oldest medicinal plant used to treat infections. This review discusses the efficiency of naturally active ingredients in banana plants. The study evaluates the antimicrobial properties of banana (*Musa sapientum*) Blossom extract against Gram-positive and Gram-negative bacteria. The extracts were tested, focusing on the use of disc methods and Minimum Inhibition Concentration (MIC). The ethanol extract demonstrated antibacterial properties against the microorganisms tested. The study examined the antimicrobial properties of Musa paradisiaca flowers using EtOH and EtOH: water extracts. The extracts were tested against various bacteria. Results showed that the extracts showed potent antimicrobial activity. The by-products of banana cultivation were extracted and tested for antimicrobial activity against various bacterial strains. The extracts showed antimicrobial properties against all microorganisms tested, with MIC values ranging from 1.2 to 2.5 mg/ml.

Keywords: Antimicrobial activity, Disc methods, Medicinal plants, Minimum Inhibition Concentration.

Socio-Demographic Insights and Risk Patterns of Tuberculosis Patients in South 24 Parganas District of West Bengal

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ABSTRACT

This hospital-based prospective study aimed to assess the socio-demographic profile and basic risk factors associated with tuberculosis (TB) among patients registered under the Revised National Tuberculosis Elimination Program (RNTEP) in South 24 Parganas, West Bengal, India. A total of 1743 newly diagnosed TB patients enrolled between 2011 and 2014 at the TB-DOT centre were included. Data were collected using a semi-structured questionnaire focusing on socio-demographic variables and baseline health characteristics. The findings revealed that over 95% of TB patients belonged to lower socioeconomic strata and exhibited poor literacy levels. A significant proportion of cases were reported among non-agricultural labourers and cultivators. Among young adults, TB prevalence was notably higher among females from the lower or upper-lower socioeconomic groups. Furthermore, the study found that male patients were more likely to default on treatment than female patients. The analysis highlighted key risk factors such as poor nutritional status, presence of other chronic illnesses, gender, and socio-economic disadvantage. These insights underscore the importance of integrating socio-demographic considerations into TB control strategies. The results can inform the development of region-specific interventions aimed at improving treatment adherence and overall TB management.

Keywords: Mycobacterium tuberculosis; tuberculosis; socio-demographic factors; multi-drug resistance

A Lepidopteran Odyssey: Discovering the Butterflies of Buxa Tiger Reserve

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ABSTRACT

Buxa Tiger Reserve, located in the Alipurduar district of West Bengal, India, is a biodiversity hotspot nestled in the Eastern Himalayan foothills. Historically, Buxa served as a strategic military outpost and trade route during colonial times, later gaining prominence for its rich natural heritage. Declared a Tiger Reserve in 1983, it is now recognized for its exceptional ecological value, particularly as a habitat for butterflies. The unique convergence of Indo-Malayan and Palaearctic biogeographic zones, along with diverse altitudinal and climatic conditions, makes Buxa an ideal refuge for Lepidoptera. Over 300 butterfly species have been recorded in this region, including several rare and endemic ones, marking it as one of the richest butterfly zones in India. This study synthesizes existing literature and field studies on butterfly diversity in Buxa Tiger Reserve, with a specific focus on abundance patterns, seasonal fluctuations, and habitat preferences. It highlights major threats faced by butterfly populations, such as habitat fragmentation, deforestation, invasive plant species, and climate change. Furthermore, the study assesses the impact of conservation measures, including community engagement and eco-tourism, and identifies research gaps that need addressing to formulate effective conservation strategies. By providing a comprehensive overview, this analysis aims to support ongoing efforts to preserve the butterfly diversity of Buxa for future ecological and scientific benefit.

Haematological Assessment of Polyvinyl Chloride (PVC) Toxicity on *Oreochromis Niloticus* (Linnaeus, 1758), A Commercial Freshwater Fish

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ABSTRACT

Plastic pollution in aquatic systems is an escalating concern, with microplastics increasingly recognized for their toxicological effects on freshwater organisms. This study has assessed the haematological responses of *Oreochromis niloticus* (Linnaeus, 1758) following chronic dietary exposure to Polyvinyl Chloride (PVC) microplastics. Healthy Tilapia were divided into five groups (n=3 per group): a control group and four treatment groups receiving feed mixed with 1%, 1.5%, 2%, and 2.5% (w/w) PVC microplastics, respectively, over a period of five months. Key haematological parameters, including Haemoglobin (Hb) concentration, Packed Cell Volume (PCV), Erythrocyte Sedimentation Rate (ESR), Total count of erythrocytes (RBC) and leucocytes (WBC), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC), and osmotic fragility test (OFT), and length and breadth of RBC were estimated, calculated and measured. The results revealed a significant dose-dependent decline in Hb, PCV, and RBC count that indicates anemia and suppressed erythropoiesis. Concurrently, a marked increase in WBC total count indicated an immunological response to toxic stress. The MCV and MCH values were elevated, whereas MCHC declined, indicating the development of macrocytic hypochromic anemia. Additionally, increased osmotic fragility of erythrocytes in higher-dose groups pointed to compromised membrane integrity. There was a marked increase in the length and breadth of RBC; length was found to be more affected than breadth.

This study demonstrates that PVC microplastic ingestion induces measurable haematotoxic effects in *O. niloticus,* making blood-based biomarkers effective indicators of microplastic-related stress in freshwater fish.

Keywords: Microplastic, Haematology, *Oreochromis niloticus PVC*

Investigation Of Nano-Phytocompound in Combating Bacterial Wound Healing in Mice Model and Fibroblast Cell Line

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ABSTRACT

Nature and natural components have been in use from time immemorial for healing several ailments of humankind. Presently, pertaining to the side effects incurred by the use of chemicals in synthetic drug materials, people are more inclined towards the usage of natural phyto-compounds as therapeutic agents against a myriad of diseases. In the present study, green synthesis of nanoparticles with phyto-compound, Chlorophyllin (CHL), which are easily available and affordable in green vegetables, has been used to investigate their efficacy against bacterial wound healing and its associated complications in L929 fibroblast cell line and in Swiss albino mice model. The results revealed that the average size of the nanoparticles NCHL was around 60nm with a smooth surface area, without any cracks, and with a negative zeta potential. The NCHL could effectively combat the structure and morphology of skin tissue in the mice model and ameliorate DNA damage and nuclear condensation by modulation of NFKβ protein. The *in vitro* assessment reveals that the non-toxic nanoparticles could heal the wound area in L929 cells effectively, which corroborates well with the ADMETlab2.0 predicted value scored via *in silico* studies. Therefore, this study definitely suggests a possibility of using this nano-phyto-compound to be used for bacterial wound infection associated with any other disease or alone and render a better life with a longer life in humankind in the days to come.

Keywords: Chlorophyllin, nanoparticles, wound healing, NFKβ

Unraveling Mate Choice Dynamics in the Bengali Population: An Ethno-Biological Perspective through Quantitative Analysis

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ABSTRACT

This seminar presents preliminary findings from an anonymous, questionnaire-based study exploring long-term mate choice patterns—specifically marriage—within the Bengali population. The research investigates human mating strategies through the lens of behavioral ecology and evolution, employing quantitative methods to analyze data gathered across a wide array of socio-demographic variables, including age, gender, height, weight, educational background, occupation, income level, religious affiliation, caste identity, perceived attractiveness, locality of upbringing, current residence, ancestral roots, and mother tongue. Although the full-scale analysis is ongoing, the session will outline the methodological design, share demographic trends observed in the dataset, and offer early interpretations of preference patterns versus actual partner traits. These insights aim to illuminate regional nuances in mate selection and contribute to the broader understanding of the ethno-biological factors that shape human reproductive behavior. The discussion will set the foundation for more advanced future research on mate choice within culturally distinct populations.

Keywords: Mate choice; Behavioral ecology; Bengali population; Human mating strategies

Abundance, Distribution & Characterisation of Microplastics from Surface Water in Matla-Bidyadhari River Beds of Sundarbans, India.

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ABSTRACT

Microplastic (MP) pollution has emerged as a pervasive environmental threat in both terrestrial and aquatic ecosystems, owing to the breakdown of larger plastic debris into microscopic particles through physical, chemical, and biological processes. These MPs, composed of toxic polymers such as polyethylene (PE), polystyrene (PS), polypropylene (PP), and polyethylene terephthalate (PET), are persistent, bioaccumulative, and hazardous to ecological health. The current study investigates the abundance, distribution, and characterization of microplastics in the surface waters of the Matla and Bidyadhari Rivers within the Indian Sundarban Biosphere Reserve, a critical mangrove wetland and Ramsar site.

Water samples were collected from ten sites—five along each river—during low tide and subjected to a modified NOAA extraction protocol involving wet peroxide oxidation and density separation using $ZnCl_2$. MPs were subsequently classified into five morphological categories: fibers, films, foams, fragments, and filaments. Results revealed a significant variation in MP abundance across sampling sites, with the highest concentrations observed in Vojor Khal (MS2) of Matla River (29 particles/10L ±1.73) and Balikhal (BS1) of Bidyadhari River (10.66 particles/10L ±3.28). Fiber-type MPs dominated in most sites, suggesting domestic and fishing-related sources. One-way ANOVA analysis indicated statistically significant differences in MP abundance across Matla sites but not in Bidyadhari.

This preliminary assessment highlights the spatial heterogeneity of microplastic contamination linked to anthropogenic activities in the Sundarban riverine system.

Keywords: Microplastic; Matla-Bidyadhari; Fibers.

Crucial Inland Stopover Wetlands Adjacent to East Kolkata Within the Intercontinental Migration Route of Shorebirds – An Overview

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ABSTRACT

The inland wetlands adjacent to East Kolkata, fragmented by rapid urban development, form a crucial part of the Central Asian Flyway and function as significant stopover sites for intercontinental migratory shorebirds during their return migration. These sites provide critical foraging habitats, especially during early spring, enabling shorebirds to replenish energy lost during long flights and synchronize their physiology with breeding conditions. This study focuses on two key inland wetland systems — Site 1: Kamudani-Khoribari, and Site 2: Kamarganti — characterized by seasonal mudflat formation, nutrient recycling, and resource generation through fisheries management. We accumulated arrival, departure, and assemblage data for a span of three years of field surveys, records of citizen science, and stakeholder interaction. The study reveals that these wetlands attract a handy diversity of shorebird species and function as crucial migratory hubs. The assemblage, stay duration, community shift over the month, i.e., the overall migratory phenology, is strongly correlated with the fisheries management practice of the area. However, increasing threats from urban development and habitat transformation call for urgent habitat conservation strategies and predictive action plans.

Keywords: Inland wetlands, stopover sites, shorebird migration, seasonal mudflats, East Kolkata wetlands

Traditional Knowledge and Pteridophyte Diversity of Cooch Behar: Bridging Local Wisdom with Global Sustainability

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ABSTRACT

Pteridophytes (Ferns and Fern-allies) represent an ecologically and ethnobotanically significant group of plants, playing a crucial role in biodiversity conservation and human well-being. The present study provides a comprehensive checklist of the pteridophytes in the Cooch Behar district, West Bengal, India, with an emphasis on their ethnobotanical uses. A total of 49 species belonging to 28 genera and 17 families were recorded. Among these, 39 species were found to be utilized traditionally by local communities for diverse purposes, including ethnomedicine, food, ornamentals, decoration, and as green manure, among others. Such widespread utilization highlights the close cultural and livelihood connections between rural communities and the diversity of pteridophytes. The study highlights that traditional knowledge, when integrated with scientific documentation, contributes not only to the preservation of biocultural heritage but also to the development of sustainable practices in health, food security, agriculture, and ecosystem management. In the context of global challenges, ranging from biodiversity loss to climate change and food insecurity, an integrative approach combining ethnobotany and conservation biology offers valuable solutions. The pteridophyte diversity of Cooch Behar thus represents not only a regional asset but also a potential resource in addressing broader issues of sustainable development and resilience. The findings suggest the need for conservation and community-based efforts to protect both the pteridophytes and the traditional knowledge related to them.

Keywords: Pteridophytes; Traditional knowledge; Sustainable development; Integrative approach.

Chemical Sciences

Induction of self-assembly in single stranded poly polyriboadenylic acid by the alkaloid cryptolepine

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ABSTRACT

RNAs have emerged as well-known therapeutic targets over the years owing to their roles in vital cellular processes such as transcription, translation and protein synthesis. The biological roles of RNA are mostly directed by their structural morphology. Thus, molecules that can alter or modulate RNA structure are quite sought after. Cryptolepine (CRP), an indoloquinoline alkaloid, is traditionally used as an anti-malarial. It also boasts of wide range of pharmacological properties such as anti-inflammatory, anti-cancer, anti-bacterial *etc*. The interaction of CRP with single stranded polyriboadenylic acid [poly (rA)] was studied in 10 mM citrate phosphate buffer of pH 7.0 at 25 °C using multi-spectroscopic approach. Polyadenylate is associated with control of gene expression and renders longevity to eukaryotic cells. Polyadenylate polymerase (PAP) is the enzyme responsible for adenylation of mRNA tails- this enzyme is linked to different cancers. Molecules that bind to poly (rA) can interfere with PAP and alter the encoded protein synthesis. In this regard, it was observed that CRP binds to poly (rA) with a binding order of 10^3 M^{-1}. CRP causes the single stranded poly (rA) to become double helical on binding to it. This was confirmed from thermal melting and CD studies. This ability of CRP to induce self-structure formation in poly (rA) makes it useful in development of alkaloid-based chemotherapeutics.

Keywords: single stranded polyriboadenylic acid; cryptolepine; self-structure formation; thermal melting.

A comparative study for the synthesis of TAM receptor kinase inhibitors core (R)-2-((4-(4-amino-2-fluorophenoxy)-1-(4-methoxybenzyl)-1H-pyrazolo[3,4-b]pyridin-3-yl)amino)propan-1-ol

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ABSTRACT

Receptor Tyrosine Kinases (RTKs) are critical signaling hubs governing essential cellular processes like growth, survival, migration, and differentiation. Dysregulation of specific RTK families, particularly the TAM receptors (Tyro3, Axl, MerTK) and the MET receptor (c-MET/HGFR), is a hallmark of numerous aggressive cancers, contributing to tumor initiation, progression, metastasis, therapy resistance, and immune evasion. Consequently, developing inhibitors targeting these receptors represents a major frontier in precision oncology.

In 2023, Beijing Anshi Biotechnology Co., Ltd. reported inhibitory activity for the structural analogs featuring the core motif (R)-2-((4-(4-amino-2-fluorophenoxy)-1H-pyrazolo[3,4-b]pyridin-3-yl)amino)propan-1-ol. These compound targets kinases associated with c-Met, VEGFR-2, Axl, TAM receptors, NTRK, and RET.

In their initial route scouting efforts, Pfizer disclosed a ten-step synthesis of aforementioned compound commencing from ethyl 2-cyano-3-(dimethylamino)acrylate, achieving an overall yield of ~25%. Subsequent development yielded an optimized five-step synthetic protocol to access the deprotected analogue, starting from 2,4-dichloronicotinic acid, which proceeded in 49% overall yield. In contrast, Beijing Anshi Biotechnology developed a concise six-step route originating from 4-chloro-1*H*-pyrazolo[3,4-*b*]pyridine; however, the overall yield was not disclosed. We, recently, undertook a detailed investigation of the patented synthetic route to further optimize the process for the synthesis of the targeted compound. The detailed results will be discussed at the Conference.

Keywords: TAM inhibitor; Selective S_NAr reaction; Pyrazolo[3,4-*b*]pyridine; Ullmann reaction.

Reference: X. Zhu, B. Liu, B. Li, S. Mondal, S. Debnath *Org. Process Res. Dev.* **2025**, 29, 2116-2123.

N, N, O coordinating fluorescence sensor emits greenish fluorescent colour in presence of Zn(II) ion and its application towards logic gate

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ABSTRACT

The pharmaceutically important methyl-substituted derivative of salicylaldehyde and imidazole-based Schiff base moiety has been synthesized and carried out its cations sensing behavior. The probe HL selectively binds with Zn^{2+} ions and gives an intense emission band at 505 nm. The determination of Zn^{2+} ions by the probe is not interfered by the presence of other metal ions viz. K^{+}, Na^{+}, Ca^{2+}, Ni^{2+}, Cd^{2+}, Co^{2+}, Mn^{2+} and Cr^{3+}. However, in the case of Cu^{2+} causes the fluorescence intensity was surprisingly quenched. The fluorescence spectral pattern in the presence of Zn^{2+} ion and Cu^{2+} ion inputs, and the corresponding truth table with logic circuit gives INHIBIT function. The formation of 1:2 (M:L) complexes and their corresponding association constants, K_{assoc} observed at 2.5 x 10^{4} (for Zn^{2+}) and 3.45 x10^{5} M^{-1} (for Cu^{2+}) have been estimated with the help of the Benesi-Hildebrand method.

Keywords: Synthesis; Cation sensing; Emission; Logic gate.

Artificial Intelligence as a Catalyst in Chemical Science Research

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ABSTRACT

Simulation of human-like intelligence by machines is known as artificial intelligence (AI). Now, machines can read and understand the complex experimental data directly, with or without human intervention. The transformation of the scientific research environment in chemical science has changed dramatically since 2015. The lightning speed of data processing by AI has reduced the slow and time-consuming manual efforts. At present, AI is invaluable at various levels in chemistry research, such as studying the bioactivity of new drugs, optimizing new reaction conditions, and refinement of synthetic protocols for new molecules. The development of AI is outpacing its adoption as a tool in chemical science research. Thus, there are tremendous opportunities to understand the potential of AI and implement it in the current landscape of research.

Keywords: Artificial intelligence; Machine learning language; Chemical science.

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Unravelling the reactivity profile of histidine in bioconjugation chemistry

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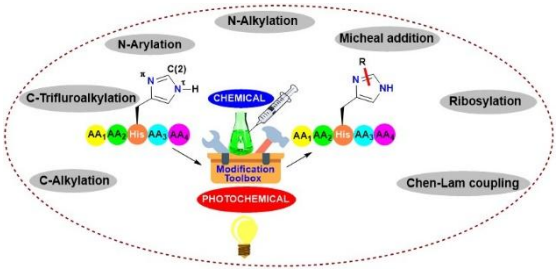
ABSTRACT

Histidine (His, H) is a proteinogenic amino acid bearing an imidazole side-chain possessing two nitrogen atoms at positions N(π) and N(τ) with some special features[1]. The aromatic imidazole ring has a pKa of approximately 6, and the nitrogen atoms are nucleophilic in nature.[2] They can serve as a base, while the protonated state can serve as an acid in enzyme-catalysed reactions. The C(2) atom situated between two nucleophilic centres is electrophilic in nature (Figure-I). As a result, H-residues in peptides and proteins undergo both nucleophilic and electrophilic posttranslational modifications.[3,4] In this review, we assimilate and analyze the development of chemical tools for the modification of H-residues in chemical and biological systems. We will also spotlight the application of these protocols in proteomics, drug discovery, targeted drug delivery, etc. The article aims to highlight the literature gaps and new opportunities for the sake of future innovation in the field.



Keywords: Histidine; Polypeptides; Bioconjugation.

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A Review on Water Purification through Dye Removal using Versatile Adsorbents and Different Biodegradation Techniques

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ABSTRACT

Uncontrolled release of dyes as industrial effluents is one of the primary causes of environmental pollution. In most areas, this release is not well controlled, and hence pollution level increases much more than designated levels. Most of these dyes are toxic and cannot be degraded in atmosphere. Some microorganisms consume these materials; due to shrinkage of natural wetlands, such possibilities are diminishing. As a result, huge amounts of untreated dyes are retained in Nature. Several types of adsorbents have been developed to encounter this problem. Various physicochemical and biological treatments have been studied, which exhibit varying removal abilities depending on their experimental constraints. In related works, supramolecular gels have been largely used for the mentioned purpose. Treatment of dye polluted water with the dried xerogel of peptide-based small molecules resulted in efficient removal of dye molecules. On the other hand, ionogels, which are ionic liquid imbibing small molecules, have also shown promising results is dye removal. With increasing importance of sustainable methods, bioremediation have also been practised largely. In a consequent work two fungal strains, *Pleurotus pulmonarius* and *Pleurotus ostreatus* have been used in terms of their biodegradation ability of different dyes. Interestingly, biomass of cigarette filters was also significantly reduced with these fungal strains. The present article summarizes various techniques of treating organic dyes, with specific focus on bioremediation.

Keywords: Dye removal; bioremediation; water; adsorption; biodegradation; supramolecular gels.

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Emerging Trends in Fluorescence and Electrochemical Sensors: Approaches to Modern Analytical Challenges

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ABSTRACT

Fluorescence and electrochemical sensors have emerged as powerful analytical tools for the detection of biologically and environmentally significant analytes due to their high sensitivity, selectivity, and rapid response times. Fluorescent molecular probes, particularly those designed for the detection of heavy metal ions like Hg^{2+} and Al^{3+}, as well as neurotransmitters such as dopamine, exhibit excellent photophysical properties, including large Stokes shifts, high quantum yields, and reversible signal response. Advances in nanomaterial-based platforms have further enhanced fluorescence signal output, enabling more precise, real-time monitoring even in complex biological environments. Additionally, stimuli-responsive fluorophores, such as pyrazole-functionalized systems, offer visible light-triggered switching, enhancing their applicability in innovative sensing systems. On the other hand, electrochemical sensors, especially glucose biosensors, continue to play a critical role in clinical diagnostics and metabolic monitoring. Recent developments integrate nanostructured materials and enzyme-free platforms to improve sensitivity, stability, and miniaturization. Such systems are increasingly being used for non-invasive or wearable monitoring applications. Electrochemical detection, based on redox reactions at electrode interfaces, complements fluorescence techniques by offering low-cost and scalable diagnostic solutions. Together, fluorescence and electrochemical sensors represent a synergistic approach in analytical science, offering broad applicability in medical diagnostics, environmental surveillance, and industrial quality control. Continued innovation in materials and molecular design is expected to drive further advancements in both domains.

Keywords*:* Fluorescent Sensor, Electrochemical Detection, Nanomaterials, Biosensing

Sustainable Development for the Synthesis of Biologically Active Organoselenides

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ABSTRACT

Selenium plays important physiological roles as an essential micro-nutrient in living beings. The Selenium based organic compounds are also found to be potential in medicinal and pharmaceutical fields with anti-HIV, anti-SARS-CoV-2, anti-cancer, anti-ulcer, antitumor, antibacterial and antioxidant properties. Organoselenides are also found to be effective catalysts in large array of important reactions. These compounds can also act as ligands in several metal catalysed reactions. They are also found to be important material building blocks. Organo-diselenides bearing Se-Se bond are the key synthons for the synthesis of library of organoselenides with important applications in various fields of science. Such molecules have been employed in metal catalysed cross-coupling, C-H activation, photo-catalyzed reaction, metal free substitutions for seleno-functionalization in saturated and unsaturated carbons of different organic scaffolds. Herein, we have recently developed a novel Ag catalysed protocol for the synthesis of diaryl diselenides under mild reaction conditions. A library of diselenides has been synthesized and employed in different reaction conditions to produce biologically and medicinally important selenides.

Keywords: Diselenide; Silver; Catalysis; Coupling.

Chemical fixation of carbon dioxide into cyclic carbonates catalyzed via Cu(II) complex of a N and S containing Schiff-base ligand: X-ray crystallography of the Cu(II) complex

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ABSTRACT

A new dinuclear Cu(II) complex, ($C_{36}H_{66}Cl_4Cu_2N_{10}O_2S_2$) was synthesised by the reaction of Cu(II) chloride with the N and S containing Schiff-base ligand **L**. The complex was characterized by several physico-chemical and spectral parameters and finally by single crystal X-ray diffraction studies. X-ray diffraction studies on the Cu(II) complex exhibited that the complex crystallized in monoclinic $P2_1/c$ space group. The ligand **L** was bonded to the Cu(II) ion in bidentate fashion through the pyrazolyl (tertiary) ring nitrogen atom and nitrogen atom in the thiadiazole ring. Cyclic voltammogram of Cu(II) complex showed a quasi-reversible Cu^{II}/Cu^{III} couple with irreversible Cu^{II}/Cu^{I} couple. The synthesized Cu(II) complex acted as catalyst for the chemical fixation of CO_2 into cyclic carbonates using epoxides in the presence of Bu_4NBr as a cocatalyst at atmospheric pressure.

Keywords: Pyrazole; Thiadiazole; X-ray crystallography; CO_2 fixation

Recyclable Ni-Schiff Base Catalyst on Calcined Eggshell for Efficient Carbon–Sulfur Cross-Coupling

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ABSTRACT

A nickel Schiff base complex immobilized on calcined eggshell (CES) has been developed as an efficient heterogeneous catalyst for carbon–sulfur (C–S) cross-coupling reactions. The CES, derived from thermally treated biowaste eggshells, serves as a cost-effective, thermally stable support with high surface area, promoting effective dispersion and anchoring of the Ni complex.

This efficient catalytic system enables the coupling of a broad range of aryl halides with thiols, affording aryl sulfides in moderate to excellent yields under mild conditions using dichloromethane (DCM) as the solvent. A series of aryl sulfides were synthesized via the C–S cross-coupling of various aryl iodides, bromides, and even less reactive chlorides with thiols, demonstrating wide substrate applicability and functional group tolerance.

The method is characterized by operational simplicity, economic viability, and the use of a reusable, biowaste-derived support. The Ni–Schiff base–CES catalyst exhibited excellent recyclability, retaining catalytic activity over five consecutive cycles with negligible loss in performance, establishing it as a robust and efficient system for C–S bond formation.

Keywords: Ni-Schiff Base Catalyst, carbon–sulfur (C–S) cross-coupling, calcined eggshell (CES)

Palladium-Catalyzed an Efficient Construction of [3,4]-Fused Oxindoles via 1,4-Palladium Migration

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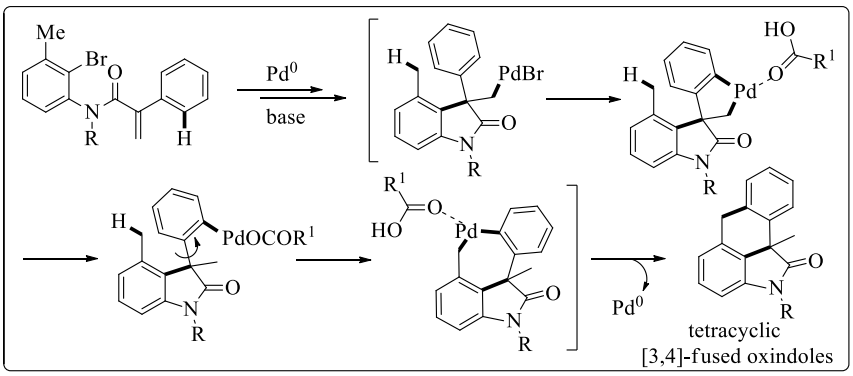
ABSTRACT

Oxindoles are present as backbone in numerous natural products, agrochemicals and pharmaceuticals. Hence, oxindoles have become important synthetic targets in recent times. A variety of transition-metals have been severely employed in the synthesis of various hetero- and carbocycles via C-H bond functionalization. However, the construction of heterocycles by palladium-catalyzed functionalization of the remote C(sp^3)-H bonds is still a promising challenge. In continuation of ongoing research on the establishment of tandem processes comprising a C-H bond functionalization, and particularly a C(sp^3)-H bond activation, it was inquisitive to transform anilides into [3,4]-fused oxindoles. It was observed that a tertiary amide was essential to obtain a domino process along with a double cyclization of various anilides. As the reaction did not give competitive products like phenanthridine and carbazole, it was obvious that the sequence of carbopalladation/domino process should be faster compare to the other possible C(sp^2)-H functionalization. The synthesis of [3,4]-fused oxindoles went through a seven-membered palladacycle intermediate via a sequence of carbopalladation/1,4-palladium shift. The reaction efficiently transformed simple starting materials to tetracyclic [3,4]-fused oxindoles.



Keyword: [3,4]-fused oxindoles, carbopalladation, 1,4-palladium shift, C(sp^3)-H activation

Synthesis Characterization and Structural Diversities of Furan Dicarboxylic Acid-Based Coordination Polymers and Their Potential Applications

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ABSTRACT

Furan-2,5-dicarboxylic acid (FDCA), a renewable and bio-based aromatic diacid, has emerged as a versatile organic linker in the construction of coordination polymers (CPs) and metal–organic frameworks (MOFs). Its rigid, π-conjugated heterocyclic backbone and bifunctional carboxyl groups allow diverse coordination modes with a variety of metal ions, leading to a broad spectrum of structural architectures ranging from one-dimensional chains to three-dimensional porous networks. This review summarizes the recent advances in the synthesis strategies—primarily hydrothermal and solvothermal methods—used to assemble FDCA-based coordination polymers. Emphasis is placed on the structural diversities enabled by varying metal centres, auxiliary ligands, temperature, pH etc. The characterization techniques employed to explain structural, thermal, optical, and magnetic properties are discussed in detail. Furthermore, the multifunctional applications of these materials are highlighted, including their roles in gas storage, chemical sensing, luminescence, magnetism, catalysis, and environmental remediation. The green and sustainable nature of FDCA, derived from biomass, makes these coordination polymers promising candidates for eco-friendly material design. Finally, current challenges and future research directions are outlined to guide the development of next-generation functional materials based on FDCA linkers.

Keywords: Furan-2,5-dicarboxylic acid; Solvothermal; Structural Diversities; Coordination Polymers

Study of some Self-assembled Inorganic Cocrystals Derived from Compartmental Schiff base Ligand

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ABSTRACT

The design and syntheses of multidimensional metal–organic framework is currently of considerable interest in the field of crystal engineering and material chemistry.[1] Crystals containing more than one chemical species called multicomponent crystals or cocrystals.[2] Since, in comparison to the large number of organic cocrystals, multicomponent crystals containing only metal complexes as the components are still rare.[2] Therefore, we have seen that this poorly explored area deserves more attention. Now attempt has been made to explore whether inclusion phenomena and formation of cocrystals are possible in complexes containing 3d-metal ions, other than copper(II), of the same ligand. Accordingly, the present study documented the syntheses, characterization, crystal structures and mass spectrometry study of the mononuclear nickel(II) compound derived from the ligand, H_2L, and the products obtained from the reaction of this mononuclear complex with the perchlorate salts of 3d metal ions.[3] The resulted compounds of composition $[\{Ni^{II}LM^{II}(H_2O)_3\}\{Ni^{II}L\}_2](ClO_4)_2$ [M = Cu, Ni, Co, Fe and Mn] are [2x1+1x2] tetrametallic systems containing self-assembled and cocrystallized one dinuclear $[Ni^{II}LM^{II}(H_2O)_3]^{2+}$ cation and two mononuclear $[Ni^{II}L]$ moieties. Among three coordinated water molecules of the dinuclear unites, two are encapsulated in the O_4 cavity of two mononuclear $[Ni^{II}L]$ moieties by forming bifurcated hydrogen bonds. Evidently, the formation of inclusion product, $[Cu^{II}L\subset(H_2O)]$, and dinuclear–mononuclear cocrystals are related to the affinity of the O_4 compartment to encapsulate a water molecule.

Keywords: Cocrystal; Inclusion compound; Mass spectra.

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Kinetics and mechanism of 1, 10-phenanthroline catalysed cerium (IV) oxidation of 2-butanol in aqueous micellar medium

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ABSTRACT

The kinetics and mechanism of cerium (IV) oxidation of 2-butanol produces 2-butanone in presence and absence of catalysts like1,10-phenanthroline (phen). 2-butanone is separated from the mixture by fractional distillation. Under the kinetic conditions, $[S]_T >> [Ce(IV)]_T$, where $[S]_T$ gives the total substrate (2-butanol) concentration, the overall process shows a first order dependence on $[Ce(IV)]_T$ and $[S]_T$. The effect of an anionic surfactant (SDS) and a neutral surfactant (TX-100) on the unpromoted and phen-promoted path have been studied. The cata- lytic effects of micelles have been explained by considering the preferential partitioning of reactants between the micellar and aqueous phases. The reaction becomes much faster when phen and TX-100 are combined together. The observed micellar effects have been rationalized by considering the distribution of the reactants between the micellar and aqueous phases in terms of the proposed reaction mechanism.

Keywords: 1,10-phenanthroline, Cerium(IV), Surfactant, 2-butanol, 2-butanone

Understanding Metal-Metal Bonds: From Fundamentals to Catalysis

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ABSTRACT

Understanding Metal-Metal bonds serve as model platforms for investigating the fundamental principles and catalytic processes pertinent to multinuclear and cluster catalysis. The close proximity of two metals, characterized by a direct metal–metal bond or interaction, frequently results in rate enhancement due to their synergistic involvement, a phenomenon commonly observed in metallo-enzymes. This lecture examines the fundamental principles that govern metal-metal bonding, encompassing electronic configurations, orbital interactions, and geometric factors that influence bond strength and multiplicity. Additionally, it explores basic redox processes, bond activation, and catalytic applications, taking into account the cooperative effect of the second metal centre. Key catalytic processes such as hydrogenation, hydroformylation, nucleophilic addition and substitution, cross-coupling reactions, polymerization, carbene and nitrene transfer reactions, as well as C–H bond activation and functionalization are emphasized to demonstrate how metal–metal interactions can improve catalytic efficiency and selectivity. Recent advancements in catalyst design that utilize metal-metal bonding highlight the dynamic relationship between structure and function, paving the way for innovative and sustainable chemical transformations. These insights contribute to a thorough understanding of the design principles for next-generation catalysts that exhibit enhanced efficiency and selectivity.

Keywords: Metal-Metal bond; Catalysis; Cooperativity

Cooperative Charge Transfer Induced Spin Transition in a Tetranuclear Fe/Co Prussian Blue Analogue Revealed by Ultrafast Spectroscopy

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ABSTRACT

The dynamics of the photo-driven charge transfer-induced spin transition (CTIST) in a tetranuclear square-type $[FeCo]_2$ Prussian blue analogue (PBA) is investigated by femtosecond IR and UV/Vis pump−probe spectroscopy. Depending on temperature, the complex $[Fe(Tp)(CN)_3]_2[Co\{en(Bn)py\}]_2(ClO_4)_2$ [1] exists in two electronic states. In acetonitrile solution, at <300 K, the low temperature (LT) or diamagnetic phase is prevalent consisting of low-spin Fe(II) and low-spin Co(III), $[Fe^{II}_{LS}Co^{III}_{LS}]_2$. Temperature rise is the reason behind thermally-induced CTIST towards the high temperature (HT) or paramagnetic phase consisting of low-spin Fe(III) and high-spin Co(II), $[Fe^{III}_{LS}Co^{II}_{HS}]_2$, being prevalent at >350 K. Photoexcitation into the intervalence charge transfer (IVCT) band of the LT phase at 800 nm induces electron transfer in one Fe−Co pair of the PBA and produces a $[Fe^{III}_{LS}Co^{II}_{LS}Fe^{II}_{LS}Co^{III}_{LS}]$ intermediate, which by spin-crossover (SCO) is stabilized within 360 fs to an $[Fe^{III}_{LS}Co^{II}_{HS}Fe^{II}_{LS}Co^{III}_{LS}]$ species (ET_1). Interestingly, this photodriven process causes a second charge transfer in the other $Fe^{II}_{LS}Co^{III}_{LS}$ pair and produces the HT species on a 900 ps timescale. This is the first demonstration of a single-photon induced cooperative CTIST at the molecular level[2].

Keywords: Prussian Blue Analogue, Charge Transfer-induced Spin Transition, Ultrafast Spectroscopy

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Synthesis, structure and magnetic behaviour of a dinuclear terephthalate bridged manganese(II) complex containing a tetradentate Schiff base

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ABSTRACT

A dinuclear compound $[Mn_2(L)_2(\mu\text{-tp})](PF6)_2 \cdot 3.57H_2O$ (**1**) [L = N,N′-(bis(pyridin-2-yl)benzylidene)-1,3-propanediamine and tp = terephthalate dianion] has been isolated and characterized on the basis of microanalytical, spectroscopic and other physicochemical properties. X-ray structural study showed interesting bis(bidentate) bridging motif of tp in the dicationic dinuclear unit $[Mn_2(\mu\text{-tp})]^{2+}$. Each manganese(II) centre adopts a rare distorted trigonal prismatic geometry with an MnN_4O_2 chromophore. Chelation of the tetradentate Schiff base (L) along with bis(bidentate) bridging of two O atoms of tp complete hexacoordination around each manganese(II) centre. The dinuclear units of **1** are associated through cooperative C-H...F hydrogen bonds and π...π, C-H...π and rare anion...π interactions to promote the dimensionality in a graded manner. Variable temperature magnetic susceptibility measurement of **1** in the 2-300 K temperature range revealed weak anti-ferromagnetic interaction presumably due to long bridging arm of tp.

Keywords: Manganese(II); Schiff base; Bis(bidentate) terephthalate bridge; Anion...π interaction; Magnetic behaviour

Anomalous p-type behavior of nitrogen functionalized graphene window: A dual Fermi level tuning and structural effect on NIR-based photodetector applications

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ABSTRACT

In this work, we delineate structural effects, in-plane hopping defects and vacancies that enhance p-type behaviour of nitrogen/oxygen functionalized reduced graphene oxide (NORG). The NORG-6/30 has been prepared from pyrazole, which is functionalized at the edge and basal plane in the NORG lattice with increasing reduction time (6-30 hours). A combined spectroscopic approach and ab initio calculation suggests that the formation of a pyrazole-based 4-pyrrole unit complex macrocyclic unit implies that in-plane hopping defects and vacancies at local sites in the graphene lattice (i.e., the graphene window) can regulate the band gap opening, Fermi level position, hole doping concentrations, and work function. Such modification and layer numbers of NORGs on Silicon nanowire substrates show remarkable NIR-based photodetector devices. Photoelectronic characterization demonstrates that the NORG-30/SiNW device shows maximum responsivity and detectivity as high as 50 mA W^{-1} and 2.2×10^{11} Jones at 720 nm wavelength at -2 V. The temperature-dependent Thermionic and Cheung's model estimates a Schottky barrier height of 0.98 eV and diode ideality factor of 2.92. The high photocurrent from photoexcited high charge carrier formation of NORG-30/SiNW device is 2 orders higher in magnitude than other NORG/SiNW and ORG/SiNW (without using any nitrogen precursors) devices. Finally, the hybrid NORG-30/SiNW device rapidly quantifies the alcohol content and has excellent potential for application in the food industry.

Keywords: Graphene, pyrazole, Fermi level, vacancies, work function, Photo detectivity

Electrochemical and Structural Insights into Cu(I)/Cu(II) Complexes: Ligand-Dependent Redox Behaviour and Superoxide Dismutation

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ABSTRACT

A series of eight mononuclear copper complexes have been synthesized and structurally characterized, including Cu(I) species $[(L1)Cu^{I}]ClO_4$ (**1**) and $[(L2)Cu^{I}]ClO_4 \cdot CH_3CN$ (**2**·CH_3CN), and Cu(II) derivatives $(L2)Cu^{II}(DMF)_2 \cdot 2DMF \cdot H_2O$ (**3**·2DMF·H_2O), $(L1)Cu^{II}(MeCN)_2$ (**4**), $[(L1)Cu^{II}(Cl)]PF_6$ (**5**), $(tren)Cu^{II}(MeCN)_2$ (**6**), $[(tren)Cu^{II}(Cl)]PF_6$ (**7**), and $(L2')Cu^{II}(DMF)_2 \cdot DMF \cdot H_2O$ (**8**·DMF·H_2O). These complexes utilize tetradentate ligands such as tris-(4-(4-(*tert*-butyl)) benzyl-3-aza-3-butenyl) amine (L1), tris(2-aminoethyl) amine (tren), tris-(4-pyren-1-yl-3-aza-3-butenyl) amine (L2) and bis-(4-pyren-1-yl-3-aza-3-butenyl) aminoethylamine (L2'), influencing both geometry and reactivity. X-ray crystallography and spectroscopic techniques confirmed the structures, revealing trigonal pyramidal geometry in Cu(I) complexes and distorted trigonal bipyramidal configurations in Cu(II) species. Electrochemical studies showed that **1** undergoes a quasi-reversible redox process at $E_{1/2}$ = 0.567 V, while **2** and **3** exhibit similar behaviour at $E_{1/2}$ = 0.405 V. The higher oxidation potential required for **1** compared to **2** highlights the ligand's role in modulating redox behaviour. Notably, **2** and **3** demonstrate excellent superoxide dismutase (SOD) mimetic activity, with an IC_{50} of 5.1×10^{-7} M. Under electrochemical oxidation, **1** forms **4**, which, upon exposure to air, transforms into **6** through oxidative cleavage of imine bonds, yielding aldehyde and carboxylic acid products in a 2:1 ratio. This points to a degradation pathway involving hydrolysis and further oxidation. Additionally, reaction of **2** with KO_2 and protons affords **8** and 1-pyrenecarboxylic acid, likely through a Cu(II)-hydroperoxo intermediate oxidizing pyrene-based aldehyde fragments. DFT calculations were employed to support these experimental insights and mechanistic interpretations.

Keywords: Copper complexes; Cyclic voltammetry; Cu-Zn superoxide dismutase; DFT studies

Role of microwave-assisted synthesis in reducing environmental pollution

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ABSTRACT

Microwave assisted organic synthesis is an environment friendly approach to synthesis as it is simple, innovative, gives high yield at low cost, and reduces the use of solvents. Conventional methods used in chemical synthetic processes involve the use of substances that are harmful to the environment. To cope with this issue, chemists were in search of a green alternative to conventional chemical practices that resulted in the development of a new branch of chemistry known as “Green chemistry”. It foresees minimum impact to the environment as a primary criterion while developing any new chemical process. This predetermined target of green chemistry is achieved by considering different gist areas such as elimination of the use of traditional organic solvents if possible, finding alternative reaction media, conditions to minimize undesirable chemical waste formation, reaction rate enhancement using microwaves as energy source, etc. Microwave technique involves energy transfer that leads to rapid and uniform heating of the dielectric materials which often results in homogeneity and increased yield of the resultant products. It has numerous advantages over conventional thermal process such as shorter reaction time, better yield product, and less energy consumption. The present article describes microwave irradiation as a valuable energy efficient alternative to the conventional heating for greener organic synthesis.

Keywords: Chromium (Vl), organic synthesis, oxochromium compounds, oxidizing agents

In-silico repurposing of Quinazoline derivatives against EGFR: Insight of molecular docking and ADMET analysis

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ABSTRACT

Non-small cell lung carcinoma (NSCLC) ranks among the most prevalent types of cancer globally. Its development is closely associated with mutations in the epidermal growth factor receptor (EGFR) kinase domain, which can be effectively targeted by specific allosteric inhibitors. While currently available EGFR inhibitors have shown clinical success, they often come with undesirable side effects. Therefore, the discovery of new EGFR inhibitors with minimal toxicity is of critical importance. In this study, bioactive Quinazolinone derivatives, along with known EGFR inhibitors, were evaluated for their potential to interact with the EGFR catalytic domain. Ten biologically active Quinazolinone derivatives, identified through literature review, were subjected to molecular docking, density functional theory (DFT) calculations, and ADMET profiling to identify promising candidates for lung cancer therapy. Among the screened compounds, Asperlicin C demonstrated the strongest binding affinity with EGFR (docking scores of -10.0 and -8.9 kcal/mol against proteins 3LN1 and 1M17, respectively), along with favourable safety characteristics in ADMET analysis. These findings suggest that Asperlicin C holds significant potential as a therapeutic agent against NSCLC by targeting EGFR, and it exhibits favourable drug-like properties warranting further investigation for cancer treatment.

Keywords: Epidermal Growth Factor Receptor (EGFR); Quinazoline derivatives, Molecular Docking, ADMET analysis.

Harnessing Graphene Oxide for Microplastic Filtration: A Nanoscale Solution to a Macro Problem

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ABSTRACT

Microplastic pollution in aquatic environments poses an escalating threat to human well-being and ecological resilience. Microplastics, though invisible to the naked eye, exert profound ecological harm by infiltrating water bodies, accumulating in living organisms, and disrupting ecosystems with insidious persistence. Graphene oxide (GO) and its nanocomposites in mitigating microplastic pollutants such as bisphenol A (BPA), polyethylene terephthalate (PET), polystyrene (PS), and polyethylene (PE) has rapidly gained recognition as an advanced filtration material. Molecular-level insights reveal pronounced interactions between the aromatic profiles of these contaminants and GO's polycyclic surfaces-predominantly governed by π–π stacking, hydrogen bonding, and van der Waals forces and demonstrated strong potential for adsorption of microplastics from water sources. GO-derived materials found to facilitate efficient photocatalytic degradation of PE-based microplastics. Concurrently, laser-functionalized GO membranes exhibit enhanced permeability and microplastic separation efficiencies. Moreover, the potential of GO-based platforms as integrated, sustainable solutions for microplastic abatement through synergistic adsorption, decomposition, and membrane filtration is a cutting-edge topic. These technologies hold substantial promise for incorporation into large-scale water purification infrastructures. Graphene oxide's unique physicochemical properties—including high surface area, abundant oxygen-containing functional groups, and excellent dispersibility in aqueous media—enable strong interactions with diverse microplastic pollutants. Its ability to adsorb, entrap, and catalytically degrade contaminants positions GO as a highly promising nanomaterial for efficient water purification and environmental remediation.

Keywords: Adsorption; filtration; graphene oxide; microplastic

Polyaniline Tin(IV) iodophosphate Nanocomposite : Synthesis, Characterization and its Practical Application in Water Purification

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ABSTRACT

The rapid urbanization and population growth is associated with an increase in the volume of wastewater production. Discharge of industrial effluents, household and hospital waste, garbage etc. into the water bodies leads to the scarcity of pure and safe drinking water[1-3]. Heavy metal ions like cobalt (II), nickel (II), chromium (VI), lead (II), and others can be toxic to life even in low concentrations[4]. Many researches are primarily focused on the synthesis of inorganic matrix-based materials for removal of toxic ions but they lack stability and selectivity. In the present approach a polyaniline based hybrid nanocomposite Polyaniline Tin(IV) iodophosphate has been synthesized and its practical utility has been assessed. The synthesized nanocomposite cation exchanger found to possess good ion exchange capacity of 2.1 meqg^{-1} for Na^+ ion. Characterization of the synthesized material using FTIR, XRD, SEM and TEM shows granulometric nature of the material with inorganic phosphate group attached to the matrix that helps in binding of metal ions and its removal. The selective removal of toxic Pb(II) ion from water makes it an ideal nanocomposite for wastewater detoxification. The synthesized material can be regenerated after its application with the retention of 80% of its initial ion exchange capacity. The potential of the nanocomposite like selectivity, chemical stability along with its easy regeneration can be useful for wastewater detoxication and water purification.

Keywords: Ion Exchange; Nanocomposite; Wastewater; Pollution.

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To The Study of Thermal, Optical and Morphological Properties of Copper Oxide Nanocomposite

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ABSTRACT

Copper oxide (CuO) nanocomposites have become a flexible group of materials with great potential in many areas, including catalysis, energy storage, sensing, and biomedical applications. Their unique properties, such as high surface area, adjustable band gap, and excellent thermal and electrical conductivity, allow CuO nanoparticles in composite materials to perform better than their bulk forms. Structural and surface analyses show that CuO is successfully integrated into different matrices. This integration leads to improved photocatalytic activity, antibacterial effectiveness, and electrochemical performance. The findings highlight CuO nanocomposites as promising materials for future sustainable and high-performance technologies with polymer matrix. It reinforced the thermal, optical and morphological properties of pure polymer matrix.

Keywords: CuO, nanoparticles, composite

Molecular Dynamics Insights into the Impact of the L110M Mutation on ATTR (105−115) Peptide Fibril Assembly

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ABSTRACT

Understanding the molecular mechanisms underlying amyloid fibril formation is essential for elucidating the pathology of transthyretin (TTR)-associated amyloidosis and for designing effective therapeutic strategies. In TTR amyloidosis, the dissociation of native tetramers into monomers initiates aggregation into amyloid fibrils. Although several TTR mutations have been investigated, the specific molecular effects of individual variants on the early stages of amyloid assembly remain insufficiently characterized. Here, we present a computational study exploring the influence of the L110M mutation on the self-assembly behaviour of the amyloidogenic ATTR (105−115) peptide segment. Using all-atom molecular dynamics simulations totalling 18 μs across triplicate 1 μs runs for each oligomeric state (dimer, tetramer, and octamer), we compared the wild-type and mutant peptide assemblies. The L110M substitution led to a consistent increase in β-sheet content relative to the wild-type: approximately 1.0% in dimers, 5% in tetramers, and 4% in octamers. Binding free energy analysis via the molecular mechanics Poisson–Boltzmann surface area (MM-PBSA) approach indicated enhanced stability in the mutant assemblies, with residue M110 contributing significantly to intermolecular stabilization. These findings suggest that the L110M mutation promotes modestly increased structural order and binding affinity in the peptide aggregates, thereby offering insights into its potential role in modulating TTR amyloidogenicity.

Keywords: peptide aggregation, oligomeric peptides, β-sheet content, MM-PBSA calculation

Reference:

1. Bhattacharya, P.; Mittal, S. *Proteins: Struct. Funct. Bioinf.* **2025** (Just Accepted)

Understanding the Influence of the Molecular Crowding Environment on the Glycation of Hemoglobin by Glyoxal

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ABSTRACT

Glyoxal (GO) is a highly reactive advanced glycated endproducts (AGEs). The production of GO is getting increased in diabetic condition. Generally, it reacts with different biomolecules and produces more AGEs. A living cell consists of a large number of biomolecules, which cover around 20–40% of the entire volume of the cell and exert crowding effects. Hemoglobin is the most abundant protein in blood. The impact of the molecular crowding environment on the glycation of Hb was evaluated in this work. In this study, polyethylene glycol 200 (PEG 200) is utilised as a crowding agent. At a definite concentration, Hb and GO were incubated for a week in 37°C with different percentages (% v/v) of PEG 200. In comparison to the control Hb, glycated Hb showed high absorbance at 280 nm, high turbidity, high browning, and a high melting temperature. Additionally, compared to control Hb, glycated Hb displayed elevated AGE and Thioflavin T (ThT) fluorescence. Circular dichroism (CD) study results showed that the secondary structures of glycated Hb contain a high percentage of alpha helix. Glycation-mediated structural changes in Hb can be restored in highly molecular crowded environment. Thus, the molecular crowded environment is an important condition that prevents Hb from being glycated. The study may mirror the actual scenario of glycation of protein in *in-vivo* condition. (DOI: 10.1039/d5cp00633c)

Keywords: Spectroscopy, Hemoglobin, Glycation, Molecular Crowding.

Mat sticks-Based N – Carbon Quantum Dot / Fe Complex for In Vivo Monitoring of Ascorbic Acid Levels

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ABSTRACT

Ascorbic acid ($C_6H_8O_6$), also known as vitamin C, is a water-soluble vitamin consisting of a skeleton of six-carbon lactone derived from fruits and vegetables. Detection of ascorbic acid in cells is crucial for evaluating antioxidant status, maintaining redox balance, supporting enzymatic functions and monitoring cellular health under physiological and pathological conditions. The system exploits the quenching effect of Fe(III) ions on the luminescence of N-CQDs, which is subsequently inhibited by the addition of AA, leading to fluorescence recovery. This sensing system offers ultrafast detection with a nanomolar detection limit, outperforming many existing assays. Notably, it demonstrates good selectivity for AA detection in the presence of various physiological molecules. The system's applicability was successfully validated in real sample assays, yielding satisfactory results. This N-CQDs-based sensing system holds promise for efficient AA detection in various applications.

Keywords: Ascorbic acid, Antioxidant, N-doped carbon quantum dots, fluorescent sensor

Excited State Dynamics in Chiral H-type Dye Aggregates: The Role of Molecular Packing Reorganization

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ABSTRACT

The self-assembly of small organic dye molecules into supramolecular architectures is governed not only by thermodynamic stability but also by complex kinetic pathways that critically influence aggregate morphology and function. Among these, H-aggregated luminescent materials are particularly attractive due to their unique photophysical properties, such as symmetry-forbidden transitions, long-lived excitons, and coherent exciton coupling, making them ideal for applications in light harvesting, sensing, and artificial photosynthesis. Incorporating chirality into such systems introduces additional control over optical behaviour, particularly enabling circularly polarized luminescence (CPL). Herein, we report the first real-time visualization of a kinetically controlled transformation from excimeric to excitonic emission in chiral H-type dye aggregates. This transition is driven by evolving supramolecular order and gives rise to distinct dual fluorescence comprising red-shifted excimeric and blue-shifted excitonic emission. Notably, the structural reorganization associated with this transition plays a key role in modulating chiral luminescence, as evidenced by the emergence and evolution of CPL signature. Photoluminescence Mueller matrix (PLMM) analysis further confirms the chiroptical evolution and provides direct insight into changes in molecular ordering and optical anisotropy. These findings underscore the importance of kinetic control in supramolecular systems and establish a new framework for designing dynamic, chiroptically active photofunctional materials.

Keywords: Excimer; Exciton; CPL; Mueller matrix.

A Porous Zinc-Based Metal-Organic Framework: Efficient Heterogeneous Catalytic System for Base Free Aldol Reaction in Aqueous Ethanol

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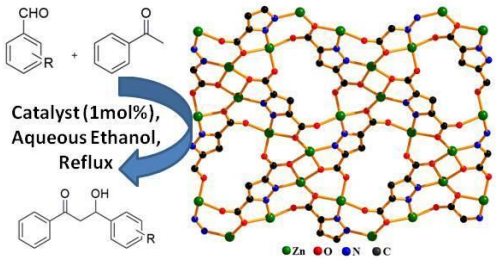
ABSTRACT

The combination of pyrazole-3,5-dicarboxylic acid (H_3pyrz) and isonicotinic Acid (Hnic) was explored in the hydrothermal conditions with $Zn(NO_3)_2 \cdot 6H_2O$ to generate a 3D Zn(II)-based coordination polymer. The primary compound has solvent-accessible void space, which increases significantly upon dehydration. In addition to the high thermal stability, the compound was evaluated as catalyst in the aldol reaction between acetophenone and various substituted benzaldehydes to produce *β*-aldol products. This reaction was carried out under environmentally friendly heterogeneous conditions, without the need for an external base, and in an aqueous ethanol (1:4) medium. The catalyst demonstrated good stability and recyclability under reaction conditions, offering practical advantages over homogeneous catalysts. Notably, this catalytic system is tolerant to air and moisture, eliminating the need for an inert atmosphere during reactions or storage.



Keywords: Metal-Organic Frameworks; Aldol reaction, Heterogeneous catalysis

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Thermodynamic Insights and Solubility of L-Histidine in Aqueous Potassium Halides (KI/KBr) at Diverse Temperature

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ABSTRACT

In this study we measure the mole fraction solubilities of L-histidine in pure aqueous solution and aqueous solutions containing halide salts of potassium, mainly KI and KBr. The measurements are conducted at six equidistant temperatures from 288.15 K to 313.15 K. An analytical gravimetrical method is used for the analysis. The goal is to better understand the biological action of L-histidine, a key amino acid acting as ROS (Reactive Oxygen Scavenger). The solubility data are used to deduce the several thermodynamical parameters of the solution. Mathematical relations are applied to determine the transfer entropies from solvent–solute interactions. The transfer Gibbs energy from solvent-solvent interactions in electrolytic environment is also calculated. Several interactions are identified, including dipole–dipole, ion-dipole interactions, and hydrogen bonding. Salting in/out constant or Setchenow constants is a key factor in thermophysical parameter variations from water to aqueous electrolytic solutions. The found positive values for this constant indicates that L-histidine is more soluble in an electrolytic solution than in a pure aqueous solution. Under experimental conditions, L-histidine is more soluble in aqueous KI than in aqueous KBr. The analysis provides preliminary insights into molecular interactions and energetics governing L-histidine solubility in aqueous as well as in aqueous electrolytic environment.

Keywords: L-histidine, Potassium halides, Thermophysical parameters, Transfer Gibbs Energy.

Three new Transition Metal ion Complexes of a Pyrimidine-based Schiff base Ligand: Synthesis, Spectroscopy, X-ray crystallography, DNA/BSA interactions and Antibacterial activities

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ABSTRACT

A pyrimidine containing 'NNN' tridentate Schiff base Ligand (**L**), and its Zn^{II} (**1**), Cd^{II} (**2**) and Hg^{II} (**3**) complexes have been synthesized and characterized by various physico-chemical and spectral parameters viz. elemental analyses, mass, IR, NMR (^{1}H and ^{13}C), UV-Vis spectral parameters and X-ray crystallographic studies. The ligand contains the coordination function of the tertiary N atoms of the pyrimidine ring, azomethine N and pyridine ring N atom, suitably spaced for chelation with the metal ions in (1:1) manner resulting in penta-coordinate (MN_3Cl_2) neutral complexes in all cases. The binding efficiency and binding mode of **1**, **2** and **3** with both CT-DNA and BSA have been studied through UV-Vis and Fluorescence spectroscopy. The binding constant values have been predicted from prescribed equations and hyperchromic shift of absorption band and the hypochromic shift of emission intensity of both DNA/BSA in presence of the compounds will be discussed. Anti-bacterial activities of all the synthesized compounds will be discussed in details.

Keywords: Schiff-base, Pyrimidine, DNA/BSA interaction, Anti-bacterial activities.

The first examples of dirhenium(III,II) paramagnetic complexes with bridging diphenylphosphinomethane and 2-mercaptopyridine ligands: A collective experimental and theoretical studies

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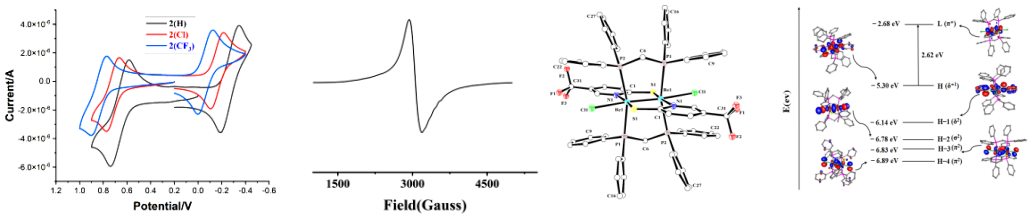
ABSTRACT

The primary interest in developing the chemistry of metal–metal bonded dirhenium complexes is their rich redox properties. Of the great variety of dirhenium complexes that are reported, only one has been isolated that contains 2-mercaptopyridine ligand in the coordination sphere. No other mercaptopyridine complexes of dirhenium are reported in the literature. It was important to explore the reaction chemistry of complex $[Re_2(\mu\text{-}O_2CCH_3)Cl_4(\mu\text{-dppm})_2]$ (**1**) [dppm is $Ph_2PCH_2PPh_2$] with 2-mercaptopyridine ligand in order to assess the stability of the Re_2^{5+} core of **1** to ligands of this type. 2-mercaptopyridine (H-pySH), 5-chloro-2-mercaptopyridine (Cl-pySH) and 5-trifluoromethyl-2-mercaptopyridine (F_3C-pySH) ligands react with **1** in refluxing ethanol to afford the paramagnetic substitution products of the type $[Re_2(\mu\text{-dppm})_2(\mu\text{-R-pyS})_2Cl_2]Cl$ (**2**(R)) [R = H, Cl, CF_3]. These are the first examples of paramagnetic dirhenium complexes that contain the bridging mercaptopyridine ligand. These complexes have very similar spectral and electrochemical properties which are also reported. The identity of **2**(H) and **2**(CF_3) has been established by single-crystal X-ray structure determination. The electronic structures and optical properties of the complexes are scrutinized by density functional theory and time-dependent DFT studies. DFT calculation shows that the highest occupied molecular orbital corresponds to a δ^* interaction between the *d*-orbitals of rhenium atoms and π^* interaction between the sulphur atoms and the rhenium centers whereas the lowest unoccupied molecular orbital is the Re_2 π^* based orbital.



Keywords: Dirhenium(III,II) complex; Crystal structure; Density functional theory; Electrochemistry

Synthesis, Characterization and anticancer activity of pyrazine Thio-hydrazone ligand-based Cu(II) complex: X-ray crystallography, TD-DFT, Molecular docking study and anticancer activity

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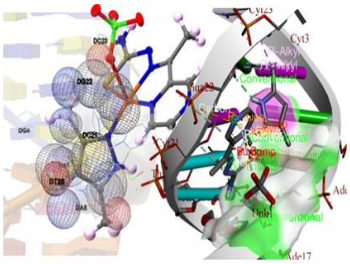
ABSTRACT

A new Pyridyl Thio-hydrazone ligand based (E)-2-(1-(pyrazin-2-yl)ethylidene)hydrazine-1-carbothioamide (**HL**), and its Cu(II) complex (**1**) –[Cu(HL)(Pz)(ClO_4)] have been synthesized and characterized with IR-spectroscopy, UV–visible spectroscopy, Fluorescence spectroscopy and X–Ray diffraction study. Structural analysis revealed that complex **1** is triclinic structure with P-1 space group, the central atom Cu(II) is square pyramidal coordination environment with N, S donor. The complex demonstrated significant cytotoxic activity against U-937 human monocytic leukemia cell line with IC_{50} = 2.39 ± 0.15 µM showed the strong potency, inducing an apoptotic pathway i, e. programmed cell death. PBMC assays confirmed low toxicity in normal cells. DNA binding studies indicated strong intercalative interaction ($K_{app} = 8.92 \times 10^6\ M^{-1}$), Chemical reactivity based on DFT study and molecular docking study with double standard human DNA (PDB ID: 1bna) also support the above result and correlating with their enhanced biological activity.



Keywords: Pyridyl Hydrazone derivative, Copper complex, Anticancer activity, DNA binding & Molecular Docking

Carbon dioxide activation and reduction on transition metal nanoclusters- A theoretical study

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ABSTRACT

We have selected a few doped and undoped Al_8, Co_8, Ni_8, Cu_8 nanoclusters to explore activation and reduction of carbon dioxide to value added fuels like formic acid, methane, ethylene, methanol etc. To understand the effect of metal doping we have chosen different transition metals (M=Sc, Ti, V, Cr, Mn, Fe, Co etc.) on Al_8, Co_8, Ni_8, Cu_8 clusters. Using density functional theory (DFT), different parameters like binding energy, adsorption energy, Mulliken charges, geometric properties, projected density of states (PDOS) have been analyzed and activation of CO_2 is found to be significant in case of Cr, Co doped nanoclusters , so we also performed different steps for formate formation mechanism. Further study of molecular dynamics reveals CO_2 is strongly adsorbed and remain attached on these nanoclusters for a long time. These findings support transition metal nanoclusters to be a suitable material for conversion of CO_2 to various reduced product, catalysis and many other applications.

Keywords: Al_8,Co_8,Ni_8,Cu_8 hollow clusters, CO_2 activation and reduction, Density functional theory (DFT), transition metal doping.

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Crystal Structure and Supramolecuar Aspects of Dipicolic Acid Based Metal Complexes

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ABSTRACT

2,6-pyridinedicarboxylic acid (pydc) which is commonly known as dipicolinic acid; is very much efficient ligands to form metal complexes. We are intaking various minerals like sodium, calcium, potassium *etc*. from environment. Some of the minerals are required and necessary for our day-to-day life within prescribed amount. But some of minerals are toxic to our human health. Even some of the minerals can be toxic if its daily intake limit exceeds. If anyone is facing such problem, doctors prescribe some chelating ligands to resolve the said issues. Because of the good chelating ability, dipicolinic acid may be effective in this field. Also, the metal complexes of dipicolinic acid show various attractive properties like cytotoxic effect, photoelectric effect *etc*. These properties can be explained by various noncovalent interactions. Here various types of interesting noncovalent supramolecular interactions like hydrogen bond, van der Waals forces, $\pi\cdots\pi$, lone pair$\cdots\pi$, halogen bonding, C–H$\cdots\pi$, anion$\cdots\pi$, cation$\cdots\pi$, anion$\cdots\pi^+$, C–H$\cdots\pi$ etc. are explored to explicit their photophysical and biological properties. Such interactions are explored in this study.

Keywords: Dipicolinic acid; Metal complex; Supramolecular interactions; Crystal structure.

Synthesis of Novel Lanthanide-Doped Layered Double Hydroxide (LDH) and its Biochar Composite for the Removal of Water Pollutants

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ABSTRACT

In this work, a novel Lanthanide-doped Layered Double Hydroxide (LDH) i.e. CuCeFe-LDH was synthesized using the co-precipitation method, maintaining a moderately basic pH. The precursor metal salts were taken in a ratio of 2:1:1. A biochar-LDH composite was also synthesized using a similar co-precipitation method, adding the biochar before introducing the alkaline medium. The structure and surface morphology of the LDH and its composite were investigated by scanning electron microscopy (SEM). The elemental composition was determined by energy-dispersive X-ray spectroscopy (EDS). To check whether any crystalline structure is present or not, the X-ray diffraction (XRD) method was used, employing a system-controlled X-ray diffractometer. FTIR spectra for both LDH and the composite were recorded in the range of 4000-400 cm^{-1}.

To show the catalytic property of synthesized LDH, the photocatalytic oxidation of Rhodamine-B dye in water medium was carried out in the presence and absence of LDH. UV-spectrophotometric estimation was performed for this purpose. The results show a significant catalytic property of the novel LDH. Different sets of experiments were also performed to understand the effects of other variables such as pHs, LDH dosage and contact-time of LDH.

Keywords: Layered-double-hydroxide; Lanthanide; Biochar: Photocatalysis.

Biochemical Approaches of CO_2 Conversion into Value Added Products

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ABSTRACT

The biochemical conversion of gaseous components to produce chemical products is considered a promising alternative when compared to existing techniques. Value added products such as Methanol and ethanol are building block of many chemicals and they are used in chemical industry in variety of ways such as alternative fuel source, antifreeze and precursors of many other compounds. The conversion of the greenhouse gas CO_2 into value-added fuels (methanol and ethanol) via biochemical approaches is required to receive more attention in C1 chemistry. However, this approach is made very challenging due to the chemical idealness of CO_2. In this review, we summarize and analyse the recent advances in biocatalytic CO_2 conversion to methanol and ethanol leaving the conventional techniques such as electrochemical or photo assisted methods behind. This review highlights the potential sources of CO_2 and its utilization followed by the current status of methanol and ethanol production and its use. Bacteria based conversion especially methanotrophic, acetogenic, cyanobacteria-based processes are discussed elaborately. Algae and enzymes are also playing important role in biochemical conversion of methanol. Biomass from renewable sources are promising pathways for CO_2 conversion and research efforts must be made to scale up these processes to industrial levels and integrate them into existing infrastructure for large-scale biochemical CO_2 utilization to value added product.

Keywords: Value added product, Methanol, Ethanol, Biochemical CO_2 Utilization

Characterization of a cationic η²-pyrrole-Pd(II) complex

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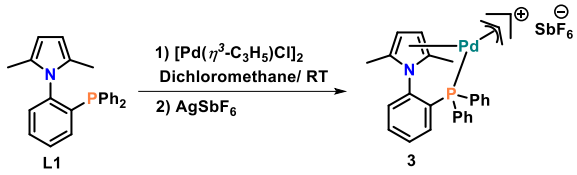
ABSTRACT

Fluxionality observed in η¹-aromatic carbocyclic-ligated Pd(II) complexes is retained when the η¹-carbon is replaced by a nitrogen atom via "hemilabile" η¹-pyrrole coordination to palladium. Herein, we report and characterize a neutral, tetra-coordinated chloro-pyrrole-Pd(II)-π-allyl complex that exhibits dynamic behavior at room temperature. Upon chloride abstraction with $AgSbF_6$, a cationic palladium complex is formed in which the coordination sphere is completed by η²-coordination of a C=C double bond from the pyrrole ring. This cationic η²-pyrrole-Pd(II)-π-allyl complex has been structurally characterized by X-ray crystallography. Notably, the coordination mode of the pyrrole ligand subtly varies in these isostructural complexes depending on the nature of the carbon-based ligand (σ vs. π).



Scheme 1. Synthesis of complex

Keywords: Pyrrole, Palladium, Hemilabile, π-allyl complex, phosphine

Reference:

1. Saha, D.; Sepay, N. *New J. Chem.* 2021, *45*, 10598.

Oxidative C-C Bond Cleavage of aliphatic 1,2-Diols by a Dioxygen-Derived Iron(II)-Oxygen Oxidant

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ABSTRACT

A mononuclear iron(II)-α-hydroxy acid complex [(Tp^{Ph2})Fe^{II}(benzilate)] (Tp^{Ph2} = hydrotris(3,5-diphenylpyrazole-1-yl)borate)] of a facial tridentate ligand has been isolated and characterized spectroscopically. In the reaction between the iron(II)-benzilate complex and dioxygen, the metal-coordinated benzilate is stoichiometrically converted to benzophenone with concomitant reduction of dioxygen on the iron center to form an iron(II)-oxygen oxidant. This transition metal-based oxidant can oxidatively cleave the aliphatic C-C bond of various 1,2-diols. The extent of reactivity greatly influenced by the various substituent at the 1,2-diols. The yield of the cleavage product is affected by the presence of a protic acid or Lewis acid. Based on the results from interception experiments and ^{18}O labeling studies, a mechanistic proposal of this oxidative cleavage is put forward. Overall, the results of this study provide important insights into the unique structural as well as functional properties of the reaction catalyzed by the nonheme diiron enzyme, *myo*-inositol oxygenase.

Keywords: Diol; Benzilate; Dioxygen; Oxidant; C-C bond cleavage

Review on Palladium Catalyzed Enantioselective Synthesis of Indoline Scaffold via C_{sp}^3-H Activation

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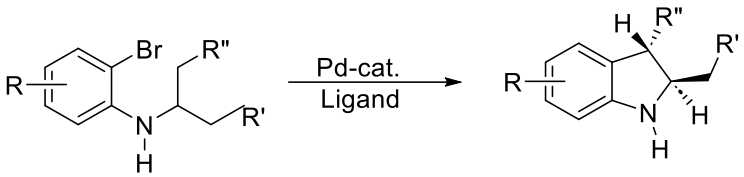
ABSTRACT

Transition-metal-catalyzed C–H activation has emerged as a powerful strategy in modern synthetic chemistry, offering efficient and sustainable approaches to constructing complex molecular architectures. Among the various transition metals employed, palladium (Pd) has proven particularly versatile due to its unique ability to facilitate selective C–H functionalization under mild conditions. Over the past decade, Pd-catalyzed C–H activation has evolved from a mechanistic curiosity into a widely applied methodology for the synthesis of pharmaceuticals, natural products, and advanced materials. This microreview describes the synthesis of several type of indoline derivatives via Pd-catalyzed reactions.



Keyword: C-H activation, Pd-catalyzed, Natural products.

A Schiff Base Derived 'Turn-On' Fluorescent Chemosensor for Al(III) Detection and Its Applications in Bio-imaging Studies

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ABSTRACT

A simple fluorescent chemosensor based on a Schiff base was synthesized by condensing 2-(2-Hydroxyethoxy)benzaldehyde with Rhodamine 6G hydrazide for the selective detection of Al^{3+} ions. Schiff bases are known for their versatile coordination properties, structural flexibility, and broad utility in sensing and biological applications. Photophysical studies were carried out under physiological conditions in a mixed organo-aqueous medium. The resulting sensor is initially non-fluorescent but exhibits a remarkable fluorescence 'turn-on' response upon complexation with Al^{3+}, showing a prominent emission at 550 nm. This fluorescence enhancement (~180-fold) is accompanied by a visible colour change from colorless to pink, with an absorption maximum at 530 nm.

Fluorescence titration and nonlinear fitting revealed a dissociation constant (K_d) of (4.87 ± 0.17) μM, indicating a strong affinity of the designed chemosensor toward Al^{3+}. Job's plot analysis confirmed a 1:1 binding stoichiometry between the probe and Al^{3+} ion. Structural characterization via NMR and IR spectroscopy validated the successful formation of the chemosensor. Furthermore, the chemosensor demonstrated low cytotoxicity and effective bioimaging performance, enabling the detection of Al^{3+} in living cells. These findings underscore the potential of this simple, efficient chemosensor for highly selective Al^{3+} detection, with promising applications in environmental monitoring and biological imaging.

Keywords: Fluorescent; Chemosensor; Schiff base; Bioimaging.

Novel Photochromic Property of [2.2]Paracyclophane Derivative

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ABSTRACT

[2.2]paracyclophane is an important scaffold used in various functional materials, such as catalysts for asymmetric synthesis, molecular sensors, solar cell devices, conducting polymers, etc. It has also been utilized to design photochromic materials. Photochromic materials are molecules which show reversible change in their structure and hence in color and absorption by the influence of electromagnetic radiation, like UV-radiation, visible light, etc. The photochromism of a novel chromene constrained to be a part of [2.2]paracyclophane, has been studied. 2,2-diphenylbenzopyran, i.e., the parent chromene, shows photoinduced coloration only at very low temperature averting its practical application, whereas the paracyclophanechromene exhibits photochromism at room temperature and thus has practical utility. The through-space delocalozation of π-electron cloud, i.e., the *phane* effect is nicely established in the two co-facially oriented aryl rings in the chromene, and is well exhibited in the stabilization of photogenerated colored *o*-quinonoid intermediates. From the X-ray determined crystal structures, the interaction between the co-facial aryl rings is clearly evident as the distance measured to be nearly 3 Å. This extraordinary stability of the colored intermediate lendsthe determination of the absorption band and decay rate of paracyclophanechromene at room temperature.

Keywords: [2.2]paracyclophane; photochromism; phane effect.

Analysis of pH Dependent Cation Specificity of NhaA, Na^+/H^+ Antiporter by Mutagenesis

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ABSTRACT

Na^+/H^+ antiporters (CPA family) are vital membrane proteins that regulate cellular pH, sodium levels, and volume. Their activity is tightly controlled by pH, but the molecular basis for this pH dependence remains unclear. Using *E. coli* NhaA—a model antiporter—we investigated a conserved "CPA motif" by engineering three mutants: D133S, I134T, and D133S-I134T. Through growth assays, transport studies, and Li^+-binding experiments, we found that Asp133 does not directly bind protons or control pH-dependent transport. Surprisingly, the I134T mutant partially lost pH regulation, while the double mutant D133S-I134T bound Li^+ independently of pH. Both mutants also showed stronger Li^+ binding than the wild-type protein. Since these residues lie near the antiporter's ion-binding site, we propose that pH sensing arises from electrostatic interactions between these positions and Asp164, a key residue in ion binding. Our findings suggest that pH control in NhaA—and likely other disease-linked CPA antiporters—stems from direct coupling between cation binding and Asp164 deprotonation. This study provides new insights into the pH regulatory mechanism of Na^+/H^+ exchangers, with implications for understanding related human transporters.

Keywords: Na^+ /H^+ antiporters, pH dependence, Ion-binding

Extraction chromatographic method for the separation of Sb(III) using poly[dibenzo-18-crown-6]

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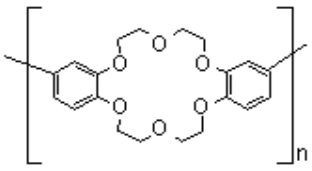
ABSTRACT

This paper reviews the analytical application of poly[dibenzo-18-crown-6] and its sorption behavior toward antimony Sb(III)) ions. To utilize the size-selective cation-coordinating ability of this cyclic poly(crown ether), it was employed as a stationary phase in column chromatography. The extractive properties of poly[dibenzo-18-crown-6] toward Sb(III) were systematically investigated. Specifically, the polymer was used as a sorbent for the chromatographic extraction and separation of Sb(III) in a glycine medium. Optimal conditions for effective sorption were established, with quantitative sorption achieved in the glycine concentration range of 1×10^{-4} to 5×10^{-1} M. The maximum adsorption capacity of the polymer for Sb(III) was found to be 0.450 ± 0.1 mmol/g. Furthermore, the effects of various parameters such as glycine concentration, metal ion concentration, and eluents were examined. The proposed method was successfully applied to the sequential chromatographic separation of multicomponent mixtures. This study highlights the potential of poly[dibenzo-18-crown-6] as a novel and efficient adsorbent for the selective extraction of Sb(III) from various sample matrices. Its high stability makes it a reliable solid support and stationary phase. The method is simple, efficient, selective, and demonstrates good reproducibility (approximately ±2%).



Poly[dibenzo-18-crown-6]

Keywords: Extraction, Separation, Antimony (III), Glycine, Poly[dibenzo-18-crown-6].

Single-Pot Synthesis of Dichloroacetyl Ferrocenes

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ABSTRACT

Synthesis of ferrocenyl derivatives are gaining importances during the last three decades. Ever growing applications of ferrocene derivatives, especially the acetyl- & substituted acetyl- ferrocenes are attracting researchers to find efficient green protocols. The goal of this research is to prepare 1,1-dichloroacetyl ferrocenes using single-pot and efficient green protocol. Reactions of ferrocene with dichloro-acetyl-chloride were found successful at room temperature using Zinc Oxide (nanoparticles) catalyst in Friedel-Crafts acylation conditions. Also, the same reaction using ionic liquid, [bmim]Cl$(AlCl_3)_X$ found successful (*where bmim=1-butyl-3-methylimidazolium; X=1.5*). Both the reactions afforded the high yields of dichloroacetyl ferrocenes in short reaction times. Recovered catalysts were also recycled without much loss of efficiency. Protocols could be identified as green methods for new ferrocenyl compounds.

Keywords: Friedel-Crafts acylation, Ionic Liquids, Ferrocenyl, Zinc Oxide.

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Supported Copper Catalysed C-2 Amination of Azoles

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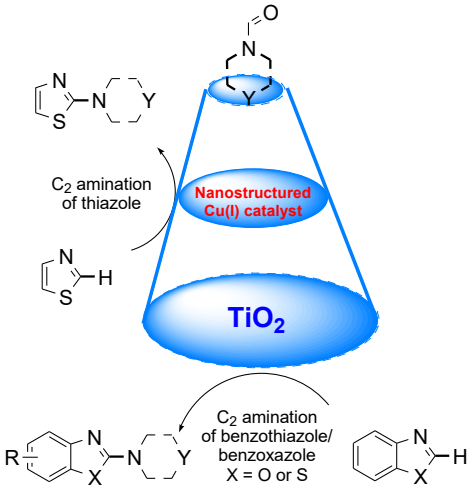
ABSTRACT

Developing green, economical, sustainable and multifunctional catalyst is one of the major challenges in organic synthesis. In general catalysts are substrate and reaction specific. Hence, creating a catalyst that can facilitate C-N bond formation in diverse substrates is extremely significant in the existing repertoire of organic reactions. Here we report[1] an array of ligand free catalytic conditions harnessing a single nanostructured-Cu(I) catalyst that enables C-2 amination among azoles (viz. benzothiazole, benzoxazole and thiazole) (Scheme 1). This strategy was further utilized towards the synthesis of a small molecule with anti-HIV and anti-tumor properties.



Scheme 1. Supported Cu nano catalysed C-2 amination of azoles

Keywords: Amination; C-H activation; Solid support; Copper catalysed

Reference:

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Synthesis, Characterization and finding some biological aspects of mixed ligand metal drug complex

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ABSTRACT

Coordination complexes of various pharmaceutical substances, including pyrazinamide, nicotinamide, nicotinic acid, theophylline, captopril, tolbutamide, clonidine, and guanfacine, with transition metals have better pharmacological and pharmacotechnical properties than parent drugs. In this reason, I have synthesised a mixed ligand Cu(II)-drug complex and characterised it using various analytical techniques, including TGA, XRD, UV-visible spectroscopy and NMR spectroscopy. Its interactions with DNA, ethidium bromide-DNA conjugate and bovine serum albumin were investigated using UV-visible and fluorescence spectroscopy, revealing a stronger binding capacity to CT-DNA and bovine serum albumin protein compared to the respective ligand alone. The study aimed to develop a metal-drug complex with enhanced biological efficacy, leveraging the synergistic effects of the transition metal and ligands.

Keyword: Synthesis of mixed ligand Complex, Structure determination, CT-DNA interaction, EB-DNA interaction, BSA interaction, Biological Applications.

Dearomatization of Benzene by Aluminium(II) Radical

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ABSTRACT

Benzene (C_6H_6) is an archetypal example of aromatic molecules, requires harsh reaction conditions for its transformations e.g. Na/liq. NH_3 is used as reagents for its reduce to 1,4-cyclohexadiene (Birch reduction). The earth abundant aluminium metal chemistry has long been dominated by its +III oxidation state, bringing extensive applications as Lewis acids catalyst in various organic transformations. However, the +II oxidation state of aluminium is much less explored due to the inherent instability of mononuclear Al(II) species as they prefer to dimerize to form compounds with $R_2Al\text{-}AlR_2$ single bond.

Here, we present synthetic approaches to generate stable Al(II) radical species through electronic reduction of diamino aluminium halide precursor. The formation of Al(II) radical is supported by EPR spectroscopic and DFT calculations. The in-situ generated Al(II) radical adds across the para position of benzene which leads to dearomatization of benzene moiety, mimicking Birch type reduction.[1]

Keywords: Aluminium(II) radical; Benzene; Dearomatization.

Reference

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Direct Plasmon-Accelerated Hydrogen Evolution Using Anisotropic Au Nanobipyramid@MoS_2 Nanohybrids

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ABSTRACT

The development of efficient, earth-abundant catalysts for light-assisted hydrogen evolution is crucial for future green energy technologies. Herein, we report a core–shell plasmonic nanohybrid, Au nanobipyramid@MoS_2 (AuNBP@MoS_2), that achieves direct plasmon-enhanced electrocatalysis for the hydrogen evolution reaction (HER) under near-infrared (808 nm) excitation. The hybrid exploits localized surface plasmon resonance (LSPR) to drive efficient hot e lectron generation, interfacial charge separation, and photothermal-assisted catalytic activity.

Under LSPR, the AuNBP@MoS_2-modified electrode shows a remarkable anodic shift in HER onset potential (–0.31 V to –0.19 V vs. RHE) and a reduced overpotential of –0.354 V at 10 mA cm^{-2}. Ethanol addition further improves performance (onset: –0.14 V), with a ~12-fold increase in exchange current density. The system demonstrates a Tafel slope of 92 mV dec^{-1} and extended hot carrier lifetimes (~5.6 s), confirming efficient hot electron injection. Impedance spectroscopy reveals significant reduction in charge transfer resistance (to 697 Ω under illumination), and the activation energy drops from 41.2 to 33.7 kJ mol^{-1}. FDTD simulations and plasmonic enhancement studies confirm strong near-field amplification at 827 nm.

Together, these results highlight the synergistic role of anisotropic plasmonics and 2D semiconductors in boosting HER efficiency. This work establishes AuNBP@MoS_2 as a potent light-responsive HER catalyst, offering new directions for solar hydrogen production.

Keywords: localized surface plasmon resonance; AuNBPs, 2-D MoS_2 NSs; HER.

Detection of Cu^{2+}, Zn^{2+}, and Ni^{2+} Ions by Fluorescein Based Chemosensor

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ABSTRACT

Metal ion contamination is a major problem worldwide because of its harmful effects when present in excess. Most of the metal ions have strong affinity to coordinate with essential bio-active molecules like enzymes. Transition metal ions like Cu^{2+}, Ni^{2+} and Zn^{2+} are important for number of biological processes in human body when present in permissible level. Due to adverse effect of metal ions presence in excess, easy detection of metal ions is an important area of research. A colorimetric and fluorometric molecular-probe was synthesized from 5-diethylamino salicylaldehyde and fluorescein amine. It was characterized and examined for metal ion sensing. In this probe salicylaldehyde moiety is used as a metal receptor whereas fluoresceine moiety functions as fluorogenic unit. The fluorescent probe showed fluorescence "*turn-on*" in response to metal ions in aqueous medium with significant colour changes from colourless to light green, yellowish-green and bright yellow upon selective binding with Cu^{2+}, Ni^{2+} and Zn^{2+} ions respectively. The synthesized molecular-probe simultaneously recognized these three transition metal ions and distinguished by absorption, emission responses with detection limit of 0.25 nM, 7.76 nM and 38.22 nM for Cu^{2+}, Ni^{2+} and Zn^{2+} respectively in HEPES buffer - Methanol (2:1, v/v) solvent system.

Keywords: Sensor; Schiff base; Fluoresce-probe.

A Combined Experimental and DFT Investigation into the Behaviour of Glycine and Glycylglycine in Aqueous 4-AP Solutions at Varying Temperatures

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ABSTRACT

The present study employed aqueous solutions of 4-aminopyridine (4-AP) at molalities of 0.001, 0.003, and 0.005 mol·kg^{-1} as solvent matrices for the investigation of the physicochemical properties of the amino acids (AAs), glycine and glycylglycine over a temperature range of 293.15-313.15 K, at ambient pressure. The origin of various interactions is uncovered by evaluating the viscosity *B*-coefficients, apparent molar volume (ϕ_V), limiting apparent molar volume (ϕ_V^0), viscosity *B*-coefficients, and discovered strong solute-solvent interaction is predominating with increasing concentrations of 4-AP over the solute-solute and also solvent-solvent interactions in the ternary mixtures. Computational modelling further supported these experimental findings, providing a coherent, molecular-level understanding of the interaction dynamics within these systems. The findings indicate that Glygly-4-AP interactions are stronger compared to Glycine-4-AP interactions.

Keywords: 4-aminopyridine (4-AP); glycine; glycylglycine; Solute-solvent interaction.

Sustainable Fischer Indole Synthesis Using Lactic Acid: Conventional and Photolytic Approaches

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ABSTRACT

Indoles are a pivotal class of heterocyclic compounds, extensively found in bioactive natural products, pharmaceuticals, and advanced materials. This study investigates the Fischer indole synthesis of diverse ketones, employing lactic acid as a biocompatible solvent to promote environmentally sustainable practices in organic chemistry. The research systematically compares conventional thermal methods with innovative photolytic approaches to optimize reaction conditions, enhance yields, and minimize environmental impact. Lactic acid, a renewable and non-toxic solvent, serves as an eco-friendly alternative to conventional volatile organic solvents, aligning with green chemistry principles. The synthesized indole derivatives were thoroughly characterized using FTIR spectroscopy, ^{1}H-NMR, and ^{13}C-NMR to verify their molecular structures and purity. The results demonstrate that lactic acid not only facilitates high-yield indole synthesis but also enhances reaction efficiency, particularly under photolytic conditions, which reduce reaction times and improve selectivity. This approach offers significant advantages, including reduced energy consumption and lower environmental footprint, making it suitable for scalable applications. The findings highlight the transformative potential of biocompatible solvents in heterocyclic synthesis, paving the way for greener methodologies in producing indole-based compounds. These compounds hold promise for applications in drug discovery, agrochemical development, and material science innovations. This research contributes to the global push for sustainable chemical processes, offering a model for environmentally conscious synthesis in modern organic chemistry.

Keywords: Fischer Indole Synthesis, Biocompatible Solvent, Lactic Acid, Photolytic Approach

A Mild Cascade Annulation for the Syntheses of Naphthoquinones, Isoflavanones, and Sugar-Based Chiral Analogues via NHC-Catalyzed Dual Stetter Reaction

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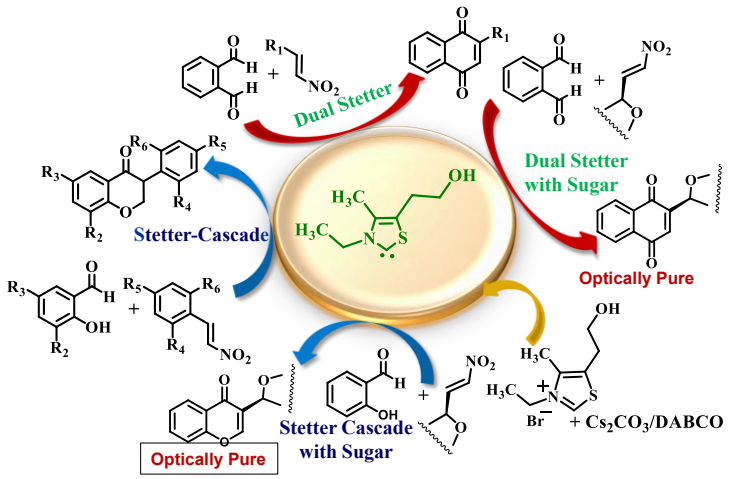
ABSTRACT

The N-heterocycle carbene (NHC)-catalyzed dual Stetter cascade reaction is discovered through coupling of β-nitrostyrene with phthalaldehyde under mild conditions to furnish valuable arylnaphthoquinones. The generality of the new reaction is validated through the development of a C−C and O−C bond forming Stetter cascade reaction using salicylaldehydes as a starting material to obtain functionalized dihydroisoflavanones. The mild NHC organocatalysis is successfully employed for the construction of optically pure sugar-based naphthoquinones and dihydroisoflavanones also (Fig. 1). Herein, NHC is found as a unique and powerful organocatalyst to construct homoatomic C−C cross-coupling, heteroatomic O−C bond formation, and cascade cyclization utilizing NO_2 as a leaving group at ambient temperature.[1]



Keywords: N-heterocycle carbene; Cascade; Naphthoquinones; Organocatalyst

Reference:

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Magnetic Field Effects on Exciplex Emission in Reverse Micellar Microenvironments

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ABSTRACT

Magnetic field effects (MFE) on pyrene–N, N-dimethylaniline (DMA) exciplex emission has been studied in reverse micellar systems, formed by ionic and nonionic surfactants such as Aerosol-OT (AOT) and Triton X-100 in nonpolar solvents. The exciplex behavior, including fluorescence lifetime and emission wavelength, has been found to be highly sensitive to microenvironmental factors such as polarity, hydration level (W_H), solvent type and temperature. Notably, longer-wavelength emitting exciplexes residing in polar core regions exhibit pronounced MFE, while those located near the hydrophobic interface remain field-insensitive. The use of D_2O instead of H_2O significantly enhances both MFE and exciplex lifetime, highlighting the role of hydrogen bonding strength and isotope effects. Temperature-dependent MFE studies in Triton X-100 further reveal dynamic interconversion among exciplex species and structural reorganization within micelles. Overall, these findings emphasize the heterogeneity of reverse micellar interiors and their ability to modulate spin-correlated phenomena. The studies provide insights into spin-dependent photophysical processes within confined nanoscale environments. A comprehensive understanding of these interactions is essential for broader applications in magnetic field sensing, molecular probe design and micelle-assisted photochemistry.

Keywords: Magnetic field effect; exciplex luminescence; reverse micelle; fluorescence lifetime

Biogenic Nanoparticles: A Comprehensive Perspective in Green Synthesis, Applications and Environmental Impacts

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ABSTRACT

Green synthesis of nanoparticles (NPs) offers a sustainable and eco-friendly alternative to conventional physical and chemical methods by employing biological entities such as plants, bacteria, fungi, and algae in an environmentally benign manner. This study provides a structured overview of the diverse applications of green-synthesized NPs across fields including medicine, bioremediation, drug delivery, environmental monitoring, agriculture, water purification, electronics, automotive, energy storage, data storage and the chemical industry. Despite their broad utility, the environmental impact of nanoparticles warrants attention, as their release into ecosystems can harm organisms and disrupt natural processes. Therefore, adopting green synthesis techniques alongside implementing effective disposal and regulatory measures are essential for ensuring their safe and sustainable use of biogenic nanoparticles.

Keywords: Nanoparticles, Biogenic, Green Synthesis, Environmental impact

Earth Sciences

Understanding the Drivers of Land Surface Temperature Change in South 24 Parganas, India

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ABSTRACT

This study investigates the effects of urbanization, population growth, and climate change on land surface temperature (LST) in South 24 Parganas, West Bengal. We examined changes over time using long-term data on built-up areas, population density, temperature, and rainfall (from GHSL, GPWv4, and CRU datasets) as well as MODIS satellite data from 2023. Areas with rapid urban growth ($Z > 1.96$) had higher LST, frequently surpassing 34°C, according to the Mann–Kendall and Sen's slope tests. On the other hand, LST was typically lower than 30°C in areas with more vegetation and water bodies. Changes in population density did not significantly correlate with LST, but trends in rainfall and temperature did have a moderately positive impact (correlation values of 0.36 and 0.48). The growth of built-up areas was the primary cause of high LST. These results imply that this coastal region is becoming more vulnerable to heat due to a combination of land use changes and climate change. The study suggests using green infrastructure, restoring wetlands, and planting trees as natural ways to lessen this heat stress. By taking these steps, the district can promote healthier living conditions and increased climate resilience. Additionally, the study assists local planners in determining the areas that require the greatest attention in order to manage environmental risks and curb temperature rise.

Keywords: Land Surface Temperature; Urban Growth; Climate Trends; South 24 Parganas.

A Statistical and Geospatial Assessment of the Efficacy of the Green City Mission on Urban Air Quality in a Newly developed Satellite Township

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ABSTRACT

Rajarhat, New Town is a planned satellite city formed on wetlands and peri-urban land under the supervision of NKDA and WBHIDCO. It was brought under the header of the Green City Mission (GCM), a policy of the West Bengal Government in 2016. It aimed to provide for an eco-friendly urban township equipped with modern amenities. Urban Air Quality deals with the amounts of pollutants or foreign agents in the ambient air. Pollutants like PM_{10}, SO_2, NO_2, degrade the environment. A primary target of the GCM was to improve the environmental quality of Rajarhat. This study aspires to bring out the utility of the GCM on the newly developed satellite township of Rajarhat. The monthly point data for 24 monitoring stations in and around Kolkata have been collected from West Bengal Pollution Control Board for PM_{10}, SO_2 and NO_2 and have been geospatially analysed to understand if there has been a significant positive impact of GCM in the concerned area. Statistical operations like two-sample t test, Mann-Kendall test have been incorporated to find out the statistical significance and monotonic trends, respectively. It was noted that after the implementation of the GCM, PM_{10} and NO_2 levels were still rising. Although, the Green City initiatives were pioneering in nature, the results reveal that a continuous monitoring and impact assessment is necessary.

Keywords: Green City Mission; Urban Air Quality; Geospatial; Pollutants.

Man-Nature-Society Triad as a Tool for Micro Regional Agricultural Planning: A Case Study of Climate Vulnerable Farming Communities in Coastal West Bengal

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ABSTRACT

Planning for climate-resilient agriculture in ecologically vulnerable areas requires an understanding of how natural, socioeconomic, and cognitive spaces interact. To investigate the spatial dynamics of vulnerability and its cognitive ramifications for farming communities, this study proposes an integrative tool called the "***Man–Nature–Society triad***" in Namkhana, a coastal agricultural block in West Bengal, India. By integrating seven parameters for exposure, sensitivity and adaptive, agricultural vulnerability was calculated using the IPCC framework as a function of exposure (E), sensitivity (S), and adaptive capacity (AC). The first three principal components, as determined by Principal Component Analysis (PCA), accounted for 80.92%, 73.9%, and 81.3% of the variance for E, S, and AC, respectively. 45 percent of the area was classified as moderately vulnerable, 25.76% as lowly vulnerable, and 14.86% as highly vulnerable according to vulnerability zoning. Based on 353 farmer responses from different zones, ordinal logistic regression showed statistically significant ($p < 0.05$) correlations between changes in rainfall, LST, NDMI, economic capital, and cognitive perceptions of climate risks (e.g., crop loss, soil fertility, and government service delivery). The study concludes that farmers' cognitive spaces are significantly shaped by both biophysical and socioeconomic factors, which should to be at the core of micro-level adaptive strategies and thus a holistic and participatory way of climate management policies could be formulated for climate vulnerable tropical coast.

Keywords: Agricultural Vulnerability; Cognitive Space; Namkhana; Ordinal Logistic Regression.

Utilizing SCAT-3 and GFS Datasets for Cyclone Analysis and Surge Simulation using SWAN+ADCIRC Model: A Case Study for Cyclone Hamoon

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ABSTRACT

ISRO-launched Oceansat-3 satellite-based SCAT-3 and model-based GFS reanalyzed wind datasets are utilized to study the severe cyclone Hamoon, which formed over the west-central Bay of Bengal and made landfall south of Chittagong, Bangladesh in October 2023, using parameters such as wind speeds, mean sea level pressure, sea surface temperature, and related sea-level elevation. The results are then compared with in-situ observations obtained from INCOIS. The maximum wind speed from SCAT-3 at landfall was 27.85 m/s, while GFS recorded 30.77 m/s. Time series analysis reveals a slight overestimation of GFS wind speeds, characterized by higher RMSE and lower correlation between buoy and GFS data compared to buoy and SCAT-3 data. The MSLP was 979 hPa, and the peak SST was 30.82°C on landfall day. Storm surge simulations using wind, pressure, and bathymetry forcing were performed using the SWAN+ADCIRC model. The simulated surge height and inundation results were validated with IMD reports and tide gauge data. The maximum water elevations are 1.3m (excluding tide) and 1.6m (including tide), aligned well with IMD's predicted range of 1-1.5m. Tide gauge validation showed an RMSE of 0.11 and a correlation of 0.9, demonstrating the strong performance of the SWAN+ADCIRC inundation model. Overall, this study highlights the importance of incorporating high-resolution wind, pressure forcing for improving future storm surge simulations in the Bay of Bengal region.

Keywords: Hamoon, SCAT-3, GFS, SWAN+ADCIRC

Impact of Sea Level Rise on Storm Surge and Associated Temporal Changes in Shoreline in North-West Bay of Bengal

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ABSTRACT

This study focuses on the impact of shoreline changes on storm surges in the Bay of Bengal. Storm surge is abnormal rise in sea level due to tropical cyclones and are described as greatest killers in cyclone. Bay of Bengal is vulnerable to cyclones and about 7 to 11% of global cyclones annually hit this region. On account of Global Warming from high industrial carbon emission, sea level is rising thereby constantly changing the shape and position of coastline which is a matter of concern. Average sea level rise in our study region is found to be about 0.35cm/year using 'CMIP6' data (Coupled Model Intercomparison Project) up to the year 2050, and study indicates 0.25m rise by the year 2050 in coastal region of Odisha and a more rapid increase of 0.44m along Sundarbans of West Bengal. Storm Surges can be modelled using a state-of-the-art hydrodynamic model 'ADCIRC' (Advanced Circulation). Simulation of super cyclone Amphan and cyclones Bulbul, incorporating sea level changes, has resulted in changes in storm surge height of about 0.4-0.6m and 0.2-0.5m respectively. Cyclones Fani and Yass were also considered. The simulations were carried out on a high performing computing facility (with 144 cores).

Keywords: CMIP6, ADCIRC, Storm Surge, Tropical Cyclone

Geotourism and Environmental Sustainability in the Darjeeling Himalayan Region: Challenges, Innovations, and Community-Based Prospects

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ABSTRACT

The Darjeeling Himalayan Region (DHR), with its fragile mountain environment and rich geodiversity, offers great promise for geotourism-led development. However, the region is facing growing environmental degradation due to unplanned tourism, changing climatic conditions, and socio-economic pressures. This paper examines how geotourism, as an interdisciplinary and sustainable approach, can support ecological preservation while promoting inclusive livelihoods. Field-based observations, stakeholder interviews, and geo-spatial mapping have been used to assess the geotourism potential of selected sites in the region. The study also explores community-based models and policy gaps affecting geosite protection. A conceptual framework is proposed that integrates earth science, environmental resilience, and local economic development. The findings highlight the urgent need for participatory planning, awareness generation, and institutional support to harness geotourism as a tool for sustainable regional growth. By aligning local practices with global sustainability agendas, this research contributes to ongoing discussions within Earth and Environmental Sciences. The study underlines the potential of geotourism to balance economic opportunities with environmental stewardship in one of India's most ecologically sensitive mountain landscapes.

Keywords: Geotourism; Environmental Sustainability; Darjeeling Himalayan Region; Regional Development

Rural-Urban Differentials in Menstrual Hygienic Practices among Women in Koch Bihar District: A Cross-sectional Study

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ABSTRACT

Background: Women's reproductive health risks are decreased and their overall health is enhanced when they maintain menstrual hygiene. A significant portion of young women use hygienic methods during menstruation. Women in rural areas practices very low menstrual hygiene compare to urban women. Unhygienic practices increases risk of reproductive health of women. Thus, the current study intends to find out the rural urban variation in the use of hygienic methods and related health issues.

Methods: The present study used primary data. The total sample of the study consisted of 403 young women aged 15–49 years. Descriptive statistics, bivariate analysis with the Pearson chi-square significant test, and multivariate analyses were applied to accomplish the study objectives.

Results: About 64% of women in Koch Bihar district used sanitary napkins. Rural women have 2 times lower menstrual hygiene practices than urban women. However, hygienic menstruation practices varied significantly by geographical areas and socio-economic background.

Conclusion: The majority of young women adopted hygienic practices, while socioeconomic and geographical differences still cause concern. Demographic and geographic stratification methods should be used to lessen regional heterogeneity and encourage everyone to utilize sanitary menstruation practice.

Keywords: Menstrual Hygienic Practice; Rural Urban variation; Factor; Koch Bihar

Assessment of Vegetation Health Using Hydro-Climatic Indices: A Case Study of Dhemaji District, Assam

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ABSTRACT

Climate change is one of the major threats to our natural environment and ecology in the present-day world. Due to the impact of climate change our natural environment is changing in a rapid way. To understand sustainable environmental monitoring and resource management, spatio-temporal characterization of vegetation dynamics and climate variability is a crucial element. The study has been carried out in the Dhemaji district, Assam, which is situated in the eastern Himalayan foreland. The district is one of the most flood-prone and ecologically fragile region where several indigenous tribes are inhabited, among them Miri, Sonowal Kachari, and Bodo are major tribes. As tribal peoples largely depend on nature and natural products, the change of the natural environment is a significant concern. This study presents the decadal spatiotemporal assessment (2014–2023) of variability in precipitation and its influence on land surface temperature and vegetation condition during the post-monsoon period. The study based on aggregate value of each index that have been used in the study such as Normalized Difference Vegetation Index (NDVI), Land Surface Temperature (LST), and Normalized Difference Moisture Index (NDMI), derived from MODIS products. These geospatial techniques have been carried out using Google Earth Engine and ArcGIS. Intra-district rainfall variability has been visualized using the Inverse Distance Weighting (IDW) interpolation method based on rainfall data supplemented by IMD. Statistical software IBM-SPSS, has been employed to construct linear regression model comprising NDVI as a dependent variable on rainfall, LST and NDMI. Regression analysis results in a significant result as an impact of these indices on vegetation health. Using the above-mentioned methods and techniques, the study tries to demonstrate a comprehensive insight to monitor the land surface condition and vegetation health of the district.

Keywords: Rainfall Variability, NDVI, NDMI, LST, Climate Change

Multiple Hazard Vulnerability Assessment through AHP and Geo-Spatial Techniques; Experiences from a tropical river basin in West Bengal

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ABSTRACT

The challenge the humankind is facing lately in the form of Climate change is multifaceted and its implications are spatially diverse. A plethora of initiatives have been taken already to study, assess, manage and mitigate the impacts of multiple hazards related to climate change. Vulnerability assessment, is the most important part of building hazard resilience. In present study, this aspect has been dealt with in perspective of Keleghai river basin, a densely populated yet frequently affected tropical river basin, situated in southern West Bengal in India. River flood is the most frequent natural hazard here. Tropical cyclones formed over Bay of Bengal often sweep the area while the basin is also infamous for periodic drought. Hence, a multi-hazard inventory is prepared for the study area where various indicators have been adopted in RS-GIS environment to represent different kinds of hazard that are responsible for creating vulnerability i.e. flood (TWI), drought (NDMI), forest cover loss (NDVI), soil erosion (RUSLE), salinization (NDSI), heat wave (LST), built-up area (NDBI)respectively. Analytical Hierarchy Process (AHP), a popular multi-criteria decision-making tool, have been used to calculate the weighted values of different hazard categories according to their degree of impact. Spatial co-relation between weighted values of the considered hazard categories has been done. By this way a multi-hazard vulnerability zone map of Keleghai river basin is prepared. It reveals that, the basin area is most vulnerable to flood. Forest cover loss and development of built-up areas are the major controlling factors of flood vulnerability. The vulnerability zone map of the Keleghai river basin thus developed may help the researchers and competent authorities to develop a comprehensive plan for risk reduction and preparedness among the local people in future.

Keywords: AHP, RUSLE, NDBI, LST, TWI, Multi-hazard vulnerability zone map.

A Comprehensive Review on Cancer Risk Through Ground Water Contamination by Radioactive and Stable Nuclides

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ABSTRACT

Groundwater is considered as the major source of drinking water in most of the rural and urban areas worldwide. Thus, contamination of groundwater poses significant eco-toxicological threats to the biosphere. Moreover, in terms of morbidity and mortality, oncological diseases rank second and about 10 million people die of cancer each year. World Cancer Research Fund (WCRF) estimates, cancer mortality may be doubled by 2030. The presence of various radioactive and stable elements, e.g., uranium (U), radon (Rn), arsenic (As), chromium (Cr), deuterium (D) etc. in groundwater is closely linked to the aetiology of various pro-carcinogenic symptoms in humans.

Uranium enters into the groundwater from different earth materials causing the risks of leukaemia, renal and thyroid cancers. Radon primarily originates from natural radioactive decay of uranium and thorium. It enters into the body through inhalation and ingestion from air and drinking water, inducing lung and stomach cancers. Arsenic intake through drinking water may lead to skin, ovarian, cervical, and genital cancers. Chromium in drinking water causes colorectal and respiratory cancers. Deuterium in drinking water is crucial for maintaining normal cell physiology, while its excess and scarcity can influence living systems at multiple levels. Deuterium-enriched water (DEW) can disrupt mitochondrial function when present in excess and induced malignancy. Conversely, deuterium-depleted water (DDW) inhibits cancer cell growth and is used as an adjuvant therapeutic agent in cancer treatment.

Keywords: Groundwater, stable and radioactive nuclides, Cancer

Spatial Patterns of Erosion hazard Hotspots Predicting Using Geo-Spatial Technology in the Lish and Gish Catchment, Darjeeling Sub-Himalaya

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ABSTRACT

Soil erosion in the form of rills and gullies endangers land stability, farm productivity and management of watersheds. We are predicting Rill and Gully Erosion Hotspots in the Lish and Gish Catchment areas using Geo-Spatial Technology in this study to investigate potential threats to erosivity and land cover. The hydrological factors that we put into consideration were intensity of rainfall, frequency of drainage, density of drainage and stream ordering; these factors were analysed to explain how and how much water flows and how it contributes to erosion. During this study, we emphasized relief characteristics, dissection index, roughness index and slope, which were examined to determine the vulnerability of the landscape to the formation of rills and gullies. The factors of land use are soil and vegetation characteristics, which are integrated to associate land coverage with the erosion measures. In a nutshell, high rainfall intensity, steep slope, high drainage density and low-order stream were already playing a key role in erosion processes, especially in the central and western side of the catchment. The lands with gravelly loamy and loamy skeletal soils had high percentages of erosion, ensuring that dense vegetation can decrease erosion. This study highlights the essence of sustainable watershed management, soil conservation, and afforestation programs as sustainable soil erosion control measures on rill and gully.

Keywords: Rills and Gullies erosion, Remote Sensing, Land use.

Evolution of Wetlands and Their Impacts on Society: Experience from Ganges Delta

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ABSTRACT

Wetlands are transitional zone between terrestrial and aquatic environment which provide a variety of ecosystem services to the humankind to sustain their livelihood. Recently wetlands in lower Gangetic Plain are facing tremendous pressure due to human interference. Present study focuses on the identification of different stages of formation of the Purbasthali and Chakundi Wetlands and how they support livelihood of the local people. Both primary and secondary data have been used to reveal such scenario. The data were collected through semi structured questionnaire and focus group discussion. The study identifies 17 ecosystem services namely food production, fuel, fresh water, flood control, habitat, recreation etc. with local importances shaping dependency of local people on the concerned wetlands. Although, their role to local folk, rapid reduction of wetlands area has been figured out. The study finds that both Purbasthali and Chakundi Wetlands have lost almost 50% area in last two decades years. Degraded wetland ecosystems have reduced dependency on wetlands especially for fishermen, landless and elders. The study also reveals that People are now facing difficulties in maintaining livelihood and thus occupational shifting is evident. Thus, protection of wetlands within the socio-ecological framework to support rural livelihood is recommended.

Keywords: Ecosystem services; food production; Livelihood; Wetland

The Problem of River Decay of River Churni and River Anjana: Special Emphasis on the Anthropogenic Impact on Rivers and the Analysis of Water Quality

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ABSTRACT

The study shows the decaying condition of River Anjana and River Churni. This also focuses on various anthropogenic impacts on the two rivers. To fulfill the objectives, RS-GIS based techniques have been accomplished and field visit has been conducted. Both primary and secondary data have been used here. Secondary data in form of satellite images and primary data in form of collected water samples have been used in this study. The entire river stretches has been sub-divided into 10 stretches based on the total length of the river. 2 kilometers buffer zone on the both side of the rivers have been created to find out the changes of water quality, vegetation quality and the percentage of land use land cover alteration within 2 kilometers buffer zone. To access the present water quality of two rivers BOD, DO and pH level have been measured in laboratory. The result of the study is very surprising. Huge alteration in land use land cover from the year 1991 to 2025 has been observed. The percentage of areas under water bodies has been decreased by 2.68 % and 8.01 % from the year 1991 to 2025 in case of river Churni and river Anjana respectively. For mitigation of channel decay, various strategies like management of stream corridor, dredging of river channel etc, should be implemented first.

Keywords: River Decay; Anthropogenic Impact; Land use alteration; River Churni; River Anjana

Antitoxin Mechanism of Clay Minerals Along with Their Pharmaceutical Applications

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ABSTRACT

Adsorption of inorganic or organic toxin molecules is one of the most distinguishing attributes of the clay minerals that facilitates a wide range of their therapeutic applications. The antitoxin potentialities of the clay minerals depend on its physical and chemical properties which are determined by its internal structure and chemical composition. The clay minerals are the major constituents of the natural clays. Recent investigations indicate that clay minerals can destroy many types of bacteria, viruses and some types of pathogens also. Clay minerals play their antibacterial and antitoxin actions in different ways. Sometimes they can destroy the cells of certain types of bacteria. Often, the bacteriostatic actions of some clay minerals prevent the growth of bacteria in the bodies of the infected hosts. Clays have tendency to form flocs in an aqueous medium in presence of electrolytes and entrap virus. A large number of viruses are rendered much less infectious when adsorbed on clay particles. The process of adsorption plays a central role in the protective actions of clays against the viruses. The aim of the study is to understand the antitoxin mechanisms of the clay minerals and their derivatives which are essential for necessary applications in the pharmaceutical industries.

Keywords: Antitoxin, Clay minerals, Adsorption, Pharmaceutical industries.

Sustainable Ecotourism Site Suitability Analysis in Bankura District Using AHP-Based MCDA and Geospatial Techniques

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ABSTRACT

Ecotourism is a sustainable alternative to conventional tourism, offers significant opportunity for environmental conservation and ecological balance. Bankura, with its diverse landscape, forested sections, cultural heritage and tribal settlement holds on great potential for ecotourism initiatives in this district. This research integrated of remote sensing and Geographic Information System (GIS) approach to assess multiple criteria according to their weighted such as soil, aspect, Land use Land cover, Elevation, Slope, Drainage, Road network, NDVI map, road accessibility, and existing tourism infrastructure. A Multi Criteria Decision Analysis (MCDA) is used to delineate pairwise compression matrix through Analytical Hierarchy Process (AHP) model. The potential site selection for developing ecotourism using geospatial data, which including several datasets like SRTM for elevation extraction, temperature and rainfall data, ground truth data for ground truthing. This model simplified the classification of the study area into four suitability classes such as low, moderate, high, and very high potential for ecotourism development. The result driven that 16.75 % of the area falls under low suitability, 25.34% is moderately suitable, 26.76% is highly suitable, and 31.13% is classified as very highly suitable for ecotourism sustainability. This sustainable eco-tourism ensures balancing conservation, local benefits and site suitability through strategic planning and regional development.

Key words: Ecotourism, Multi-Criteria Decision Analysis (MCDA), Analytical Hierarchy Process (AHP)

Spatial Assessment of Soil Erosion in Jhargram District, West Bengal: Using the RULES Model

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ABSTRACT

Soil erosion is one type of land degradation that harms agricultural productivity and ecological balance. At present, it is a critical worldwide environmental issue and also in the erosion-prone district like Jhargram. To assess the spatial distribution of soil erosion across the entire district, the Revised Universal Soil Loss Equation Simplified (RUSLE) model is used with a GIS framework. The model integrates five core input parameters: LS-factor (slope length and steepness), R-factor (rainfall erosivity), K-factor (Soil erodibility), C-factor(cover-management), and P-factor (support practice) to determine the annual soil loss in tons per hectare per year (t/ha/yr). Based on the FAO and ICAR guidelines, the estimated soil loss results were classified into three risk categories, where <2 t/ha/yr is considered as tolerable, 2-5t/ha/yr as moderate, and >5 t/ha/yr as critical. The results indicate that 84% of the district experiences low erosion, 9.66% faces moderate erosion risk, and notably, 6.34% is exposed to high erosion risk, the critical threshold, indicating severe vulnerability and a need for urgent soil and water conservation. The soil erosion risk map serves as a vital planning tool aligned with the goals of sustainable land management and supports Sustainable Development Goal 15 by helping prioritize erosion-prone zones for mitigation.

Keywords: RULES model, GIS techniques, Soil erosion, Soil conservation

A Multidimensional Focus on Issues Related to Food Security- A Study on Nadia District, West Bengal, India

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ABSTRACT

Whenever we concentrate on issues of global challenge, unanimously the issue appears before us is food security. Being the member of a country with huge population it is always a challenge for the practitioners of science and the conscious academicians to think, plan and implement properly such that none of the people have to face food insecurity. Definition of food security is related to accessibility of food and detail study of events related to continuous supply of healthy and nutrient food includes economic, climatic, land- use and pollution related issues. Present paper wishes to focus on future of food security for the district Nadia, West Bengal. Demographic study for the district reveals a huge population concentration, increased built-up lands are causing another threat on arable lands and is causing a challenge for agricultural production. Climatic challenges are another threat before agricultural production for this district like any other part of our globe. Concentration on the issue of food security from economic point of view shows another challenge for the marginal people. Poor to moderate economic status for most of the villagers and low income grouped people of urban areas face the problem of food insecurity due to least purchasing power. Current study runs with the aim to show responsibility of different streams including physical and social sciences to cope up with the future threat of food insecurity.

Keywords: food security, climate change, land-use, economic status.

Technological Advances and Globalisation-A Powerful Engine and an Automatic Route for Development?

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ABSTRACT

Since the second half of the 20th century and the beginning of the 21st, the world has witnessed technological advances on a massive scale. While it is difficult to compare the pace of current advances in technology to those which were equally impressive during the earlier centuries, memories tend to be telescopic over time, thus putting a much less weight to what happened in the past. Of the prominent innovations as have swept across the world in recent times as globalisation or diffusion, one can mention information and communications technology (ICT), micro-biology, along with some newer technology in transport, power generation, construction and many other areas. Innovations have led to new generation products along with new processes of production to replace the old. Options thrown open with these changes include a wider and superior range of products for the consumer and more sophisticated production techniques for the producer, often using a very different combination of inputs. The story, however, does not end there. New technologies necessarily replace the old and change the input combinations which include proportion of labour and capital, introducing displacement of labour.

Keywords: Technology; Globalisation; Innovation; Advancement &Development.

Spatio-Temporal Dynamics of Blue Space and Its Influence on Land Surface Temperature in the Bagri Tract, Lower Gangetic Flood Plain, West Bengal, India

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ABSTRACT

The rapid growth of human settlement in developing countries like India has caused massive changes in land use and land cover (LULC), that affecting local temperature patterns especially in urban landscape. The Bagri trat in lower Gangetic flood plain is geomorphologically significant in term of presence of numerus wetland as well as first growing landscape in terms of urbanization, and agricultural practice. The current study focusing spati-temporal changes in wetlands (blue spaces) and Built-up area and their gradual impacts on Land Surface Temperature (LST) from 2000 to 2024. Using multi-temporal Landsat imagery and index oriented geospatial techniques temporal variability of LST has been measured in different parts of wetland like patches edge, perforated and core areas. that the patch, edge, and perforated have been reduced significantly from 2000 to 2024. Such kinds of wetland transformation and decrease of wetland is mainly due to agricultural expansion, urban growth, and fast-growing economy. The gradual transformation in wetlands is consequences to an increase in LST, highlighting the role of wetlands in temperature regulation. Analysis based on distance showed a temperature difference of 2 to 2.5°C within 350 meters from wetland centers, suggesting significant cooling effects over the study area. These findings emphasize the importance of protecting blue spaces to reduce heat wave and support better decision-making for sustainable planning in floodplain areas.

Keywords: land use and land cover (LULC), Gangetic flood plain, Land Surface Temperature, Blue Space,

Engineering Sciences

Estimation of Ploughing Force with the Aid of Experimentation and Slip-Line Field (SLF) Theory

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ABSTRACT

The fundamental stage of the metal removal procedure is indentation. Cutting, ploughing, and rubbing are the three steps in the grinding process that remove metal. Early research on indentation to a ductile material used slip-line field (SLF) theories to analyse the problem and assumed that the material was ideally plastic. The indented parent material tends to form a pile up around the wedge which was taken to be linear in shape. However, later studies demonstrated that the shape of the piled-up material might be curvilinear for ideally plastic ductile materials, and the corresponding non-linear SLF theory was proposed. Ploughing can be considered as a special case of Indentation. In this work, ploughing experiments were carried out on Aluminium as parent material and normal indenting force were measured by Dynamometer. The Experimental results of normal force showed better match with non-linear SLF theory than a linear.

Keywords: Force, Indentation, SLF, Aluminium

Amazing Pattern Dynamics in the Networks of Digital Electronics Systems

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ABSTRACT

Digital phase-locked loops (DPLLs) are inevitable units of complex communication electronic systems and some control systems. There are variety of DPLLs according to their phase-locking techniques; namely, uniform sampling DPLLs, nonuniform sampling DPLLs, bang-bang DPLL, digital tanlock loop (DTL), etc. The most popular and efficient among these are zero-crossing digital phase-locked loop (ZC1-DPLL) and time delayed digital tan-locked loop (TDTL). It is extremely difficult to predict dynamical behaviors of all the DPLLs due to their inherent nonlinearity. But, in almost all modern engineering applications they operate in coupled condition. Here we describe one and two dimensional networks of ZC1-DPLLs and TDTLs with local and nonlocal coupling topology. It is found that, such networks show variety of fascinating dynamical patterns. One dimensional network of ZC1-DPLLs and TDTL show synchronized fixed point, frozen random pattern, pattern selection, spatiotemporal intermittency, spatiotemporal chaos and chimera state. Where as, in two dimensional network of ZC1-DPLLs exhibits several amazing spatiotemporal patterns like grid chimera, linear-strip chimera and wavy-strip chimera. On the other hand, two dimensional network of TDTLs additionally exhibits breathing sport chimera and inverted sport chimera. Thus we discuss the diversity of emerging spatiotemporal patterns in networks of digital systems with different coupling scheme. We also show the analytical stability criteria for the stable locked operation of these networks.

Keywords: Digital phase-locked loop; Spatiotemporal pattern; Chimera state.

Water Wave Scattering by a Porous Vertical Plate

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ABSTRACT

The interaction of water waves with breakwater type offshore structures has been a subject of interest since early twentieth century. Breakwaters are coastal structures which are widely constructed to protect a port or harbour from the effect of rough sea. Using of porous coastal structures become important as the structural voids in the porous breakwaters can dissipated wave energy efficiently. We study the problem of scattering of obliquely incident wave by a porous plate with non uniform porosity submerged in water of finite depth. Here, the problem is formulated in terms of a Fredholm integral equation of second kind where the unknown function represents the difference of potentials across the barrier. We may mention here that the integral equation here has a regular kernel which is more amenable to the numerical methods. The integral equation is then solved using two methods: the boundary element method and the collocation method. Using the solution of the integral equation, the reflection coefficient, transmission coefficient and amount of energy dissipated are determined and depicted graphically.

Keywords: Fredholm integral equation, Reflection, Transmission, Energy dissipation coefficients.

A Short Note on Technological Interventions of Artificial Intelligence for Community Development

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ABSTRACT

Artificial Intelligence (AI) is one of the most promising and fastest-growing fields, contributing significantly to numerous domains of research and application. AI can be described as a combination of *rational agents* that receive perceptions from the environment and perform actions accordingly. While the impact of Artificial Intelligence in different sectors such as education, healthcare, finance, transportation, etc., is widely acknowledged, the potential of AI to address social issues like helping disabled people, providing security via surveillance, preventing suicide attempts to protect the community is highly significant. AI technologies can also serve the society by improving various aspects of life, such as fostering a positive and supportive educational setting, improving accessibility and inclusively reducing systemic bias, supporting environmental sustainability and contributing to global security. AI may be used to automate routine workflows in industries controlling inventory management systems, performing data entry jobs, and scheduling employees. The work done by AI systems can significantly reduce the time and labour involved in such tasks. Thus by leveraging AI, we can overcome challenges and create sustainable solutions to societal problems to benefit communities. This article explores the profound impact of AI tools on community development, highlighting the innovative ways in which they are reshaping the landscape of society.

Keywords: Artificial Intelligence; Frontiers in Science; Recent Technological Interventions; Community Development

Development of a Robotic Fish to Manipulate Fish Behaviour

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ABSTRACT

Analysing of live fish behaviour is a complex area of research because, it involves monitoring of several behavioural aspects of the live fish used in experimentation. These include variation in fish locomotory patterns, interactive behaviour and so on when exposed to stimuli like predators, conspecifics, novel objects, etc. However, use of live fish makes it difficult to maintain the consistency of the behavioural pattern of both, the animal under experimentation and the animal used as the stimulus. To overcome the constraints, use of robotic fish to study fish behaviour is a quantifiable and repeatable approach commonly used in neurobehavioral research. In this backdrop, the study aimed at developing a simplified robotic fish (spatially static), which sort of mimics the movement of motor organs (tail beating) of live fish. The frequency of tail beating and angular displacement can be finely controlled through a microcontroller.

The study involved understanding the behavioural pattern of live fish in presence or absence of the robotic fish. The findings indicated a qualitative tendency of the live fish to approach the robotic fish when the opaque partition, separating the two sides of the behavioural chamber was replaced with a clear partition (visual cue). The study was performed on adult zebrafish, a common aquarium fish which is now an established animal model for neurobehavioral research.

Keywords: Robotics; Fish Behaviour; Motor Organ; Visual Cue

Blockchain-Based Smart Healthcare System Using Cloud Computing.

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ABSTRACT

Cloud-based data storage has transformed industries including e-commerce, education, research, and healthcare. This is especially important for EHR (Electronic Health Records) storage. Many healthcare providers have adopted digital records for managing patient health information as a result of the efficient and cost-effective move from paper-based to electronic health records (EHRs). However, the growing volume of patient data, along with the need to keep these records for lengthy periods of time, presents major storage, retrieval, and maintenance difficulties for healthcare providers. Because of this, more and more healthcare providers are moving their EHRs to cloud storage.

The transition to cloud storage, however beneficial, introduces increased security vulnerabilities, such as data leakage, integrity violations, and unauthorized access to electronic health records (EHRs). Potential risks are increased by the storage of data on distant servers, frequently situated in geographically disparate places, which are not directly managed by healthcare providers. Improved security measures are crucial for ensuring confidentiality, integrity, and access control. Existing research tackles specific difficulties, but there is a lack of a comprehensive security strategy for cloud storage of EHRs.

The goal of this research introduces a reliable Blockchain-based Medical Cloud (BC-MedCl) platform intended to enable safe EMR exchange between physicians and patients. These EMRs' hash values are generated by putting them into a blockchain, which secures data integrity and resistance to tampering.

Keywords: Cloud Computing, Healthcare, Contracts, Public Key.

Transfer Learning for Crop Disease Recognition: A Deep Learning Approach for Smart Agriculture

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ABSTRACT

In precision agriculture, identifying crop diseases is essential since it has a direct impact on crop productivity and food security. Conventional manual identification techniques are frequently laborious, prone to mistakes, and necessitate specialized knowledge. Automated image-based disease detection has emerged as a viable substitute with the development of deep learning. However, significant labeled data and computer resources are needed to train deep neural networks from scratch. Transfer learning has become a useful method for getting around this restriction. It allows pre-trained models to be reused on massive datasets, improving performance on domain-specific tasks like crop disease classification. This study investigates how convolutional neural networks (CNNs) and transfer learning can be used to identify crop leaf diseases. On the Corn, Rice, and Potato plant leaves dataset, which consists of a variety of crop photos taken under different disease situations, the state-of-the-art pre-trained architecture (EfficientNet-B4) has been optimized. Classification accuracy, precision, recall, and F1-score, confusion matrix are used to assess the models. The findings show that transfer learning delivers excellent disease recognition accuracy and greatly enhances model generalization, even with sparse agricultural data. The results demonstrate how transfer learning may be used as a scalable and affordable early disease detection method in smart farming systems, helping farmers and agricultural specialists make timely decisions and manage their crops.

Keywords: Transfer Learning, Crop Disease Recognition, Deep Learning, Convolutional Neural Networks (CNNs).

Lathe-Assisted Friction Welding: A Review on Recent Developments and Future Trends

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ABSTRACT

Friction welding is an efficient solid-state joining technique used for producing high-strength joints, especially tailored for welding dissimilar metals. However, conventional friction-welding setups are quite expensive and sometimes inaccessible to academic laboratories and small-scale industries. This review study explores the evolution and feasibility of employing lathe-based setups as a cost-effective and accessible alternative for rotary type friction welding. The review systematically analyses reported studies on lathe-modified systems for welding similar and dissimilar materials, with a focus on operational parameters such as rotational speed, axial load, and dwell time. Key findings related to joint integrity, hardness variations, and microstructural outcomes are compared across different material combinations like aluminium–copper, mild steel–stainless steel, etc. Special emphasis is placed on techniques that enable thermal assistance, tool design adaptability, and integration with sensor-based monitoring systems. By compiling and critically evaluating current innovations, this review highlights the potential of lathe-based friction welding setups in promoting sustainable manufacturing, particularly in educational institutes and MSMEs. The review also underscores the scope for future research, including hybrid welding techniques and digital monitoring, aligning with global goals of inclusive and affordable engineering solutions. The review thus contributes to bridge the knowledge gap encouraging further experimentation in low-resource settings.

Keywords: Friction welding; Lathe modification; Solid-state joining; Dissimilar metals

Analysis of Power Quality and Stability Issues in Modern Microgrids

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ABSTRACT

Microgrids have become an important part of moving toward energy systems that are more spread out, strong, and use more renewable energy. But keeping the electricity quality good and making sure the system stays stable are still big challenges, especially since microgrids use a lot of inverter-based distributed energy resources. This paper looks at the different factors that affect electricity quality, like voltage drops, bad wave shapes, changes in frequency, and uneven loads, both when the microgrid is connected to the main grid and when it's working on its own. It also looks at stability issues like how the system reacts quickly to changes, how control strategies work together, and when there's a mismatch between power supply and demand. Today's microgrids need smart control methods and flexible protection systems to deal with these problems, especially in real-time situations where renewable energy production and load demands change a lot. The study shows the limits of traditional ways of measuring electricity quality and suggests better ways that are more suitable for microgrids. It also looks at how new technologies like smart inverters, real-time monitoring, and artificial intelligence can help make microgrids more stable and dependable. The paper uses case studies and computer simulations to test different ways of solving these problems. By looking at electricity quality and stability in a complete way, this research helps create smarter and more dependable microgrids that can work alone or with the main grid, supporting the growing needs of modern power systems.

Keywords: Microgrid; Power Quality; Stability.

Efficiency of Truly Shift-Invariant Convolutional Neural Network for Indian Sign Language Recognition System

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ABSTRACT

Most Indian Sign Language (ISL) recognition systems rely on convolutional neural networks (CNNs) for deep learning. However, the output of CNN image classifiers can fluctuate significantly with even a slight change in the input images. This issue can be partly mitigated through techniques such as data augmentation, anti-aliasing, or blurring, but these methods often fail to work with different input patterns that the network was not trained on, and non-linear activation functions like ReLU do not fully resolve this either. This limitation can be overcome using a truly shift-invariant CNN. The system incorporates an adaptive polyphase sampling (APS) strategy for sub-sampling, which ensures true shift-invariance for the CNN. The method is highly effective for classification tasks and achieves remarkably high accuracy, not only on ISL datasets but also on datasets from other sign languages.

Keywords: CNN, Indian Sign Language, adaptive polyphase sampling

Predictive Machine Learning Modeling of Thermo-hydraulic Performance for EV Battery Cooling using Nanofluid

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ABSTRACT

Efficient thermal management is critical for the performance, safety, and lifespan of electric vehicle (EV) battery packs. Optimizing liquid cooling systems with nanofluids is challenging due to complex, non-linear trade-offs between heat transfer and frictional losses, making traditional simulation-based design computationally prohibitive. This study proposes a hybrid methodology combining Computational Fluid Dynamics (CFD) with machine learning to predict the thermo-hydraulic performance of a cooling system using a 50/50 ethanol-water based nanofluid containing CuO, Al_2O_3, Fe_3O_4, or Single Wall Carbon Nanotube (SWCNT) nanoparticles. To predict the Fanning friction factor (f) and the Colburn j-factor (j), four predictive models were developed and compared: Linear Regression, Decision Tree, Random Forest, and a Deep Neural Network (DNN). While linear models failed to capture the system's complexity, both the Random Forest and Deep Neural Network (DNN) models demonstrated exceptional predictive power, achieving coefficient of determination (R^2) values exceeding 0.99 for the friction factor and 0.97 for the j-factor on unseen test data. The primary contribution is a validated, high-fidelity surrogate model that enables instantaneous performance prediction, providing engineers with a powerful tool to rapidly optimize battery thermal management system design and accelerate the development of safer, more efficient next-generation EV batteries.

Keywords: Nanofluid, Electric Vehicle Battery Cooling, Machine Learning, Deep Neural Network.

Spectral Mixup and Triplet Loss Regularized HybridSN for Improved Hyperspectral Image Classification

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ABSTRACT

Hyperspectral Imaging (HSI) is a state-of-the-art image acquisition approach, which can capture hundreds of spectral bands for each spatial position, enabling precise material detection and landcover classification without any direct interaction with the object. Classification of HSIs refers to assigning class labels to each pixel by considering both the precise spectral and spatial information. However, the lack of training datasets, complex inter-spectral band correlations, and high dimensionality make the HIS classification very challenging. Available deep learning methods like HybridSN have achieved significant enhancement for the extraction of spectral and spatial features by merging 3D and 2D Convolutions. Besides this, these models required huge datasets and may lack feature embedding, leading to overfitting and suboptimal generalization in limited labeled samples. To address this issue, an enhanced HybridSN framework has been proposed that incorporates Spectral Mixup and Triplet Loss, which improve generalization and reduce the possibility of overfitting. Spectral Mixup augments the training data by applying linear interpolation in the spectral domain. Triplet Loss utilizes latent embedding to enforce intra-class correlations and inter-class separability. Without modification of the HybridSN architecture, forward hooks are utilized to extract embedding for metric learning, making the overall model simple and easy to implement. Experiments on benchmark HSI datasets, including Indian Pines and University of Pavia, demonstrate that the proposed approach outperforms the baseline HybridSN, achieving higher classification accuracy and better robustness under limited training samples.

Keywords: Hyperspectral Image Classification, Hyperspectral Image, Spectral Mixup augmentation, Triplet Loss, HybridSN

Performance of Different Classification Models with Multiscale Deep Feature Fusion and Compact CNNs for Lung and Colon Cancer Classification

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ABSTRACT

Computer-aided systems in medical imaging are becoming more and more popular as a result of the growing need for accurate and early cancer diagnosis. This study uses histopathological images from the LC25000 dataset to present a deep learning model for multiclass classification of lung and colon cancer. The goal is to create a dependable and expandable deep learning pipeline that can recognize five different types of tissue: colon normal and adenocarcinoma, and lung normal, adenocarcinoma, and squamous cell carcinoma. Three pre-trained compact convolutional neural networks—MobileNet, ResNet-18, and EfficientNetB0—provide multiscale deep features that are utilized by the suggested system. From the final thick layers and global average pooling, each network produces two unique feature sets. Canonical Correlation Analysis (CCA) is used to control the high dimensionality of these features, and feature fusion is then used to create a single multiscale representation. Feature selection methods like ANOVA and Chi-Squared tests are utilized to further refine this fused vector. A variety of classifiers, including as SVM, KNN, LDA, and Decision Tree, are then trained using the improved features. The system has outstanding predictive performance and clinical potential with a macro F1-score of 0.9647, a classification accuracy of 96.48%, and ROC-AUC values above 0.9 for every category.

Keywords: Multiscale Deep Learning, Histopathological Image Analysis, Cancer Classification, Feature Selection Techniques.

Digital Transformation and Change Management in Organization

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ABSTRACT

This research explains implications of digital transformation on organizational change management via a theoretical and literature-based examination. By combining present day technology like synthetic intelligence (AI), cloud computing, and facts analytics, digital transformation is converting how corporations feature, compete, and provide cost. However, fulfillment is not confident via era alone. Managing the organizational transformation that incorporates virtual projects is the actual issue. For a success adoption and lengthy-term effect, trade management and prepared technique of assisting humans by transitions is essential. Processes, roles, culture, and purchaser interactions are all impacted through digital transformation, which often reasons worker resistance because of uncertainty, tension, and talent gaps. Strong management, transparent communication, stakeholder participation, and ongoing guide are all essential for powerful change control to handle these issues. While a subculture of flexibility, mastering, and creativity fosters lengthy-time period trade, leaders are crucial in bringing vision and behavior into alignment. Further improving preparedness and responsiveness are re-skilling, agile methodologies, and remarks systems. Organizations are better geared up to reply to disruption, encourage creativity, and offer quantifiable results after they combine digital approach with thorough change control. Change management and digital transformation have to coexist. Organizations can cope with complexity, conquer resistance, and obtain the overall benefits in their virtual investments via giving same interest to people and generation.

Keywords: Digital Transformation, Change Management, Organizational Change, Leadership, Digital Strategy, Innovation, Technology Adoption, Employee Engagement.

The Living Wall: An AI-Driven Bioreactor for Urban Air Purification

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ABSTRACT

Cities globally grapple with escalating air pollution and CO_2 emissions, often hindered by insufficient space for new green areas. "The Living Wall" offers an innovative solution: a smart, compact panel system that utilizes algae to purify air. These panels, affixed to building exteriors, draw in polluted city air, allowing the algae within to absorb harmful CO_2 and release clean oxygen. An integrated AI system, equipped with sensors, monitors the algae's health and environmental conditions, automatically adjusting light, water, and nutrient delivery to optimize efficiency, making it 25% more effective than non-AI systems. Early tests indicate an 80% reduction in local CO_2, and beyond air purification, "The Living Wall" provides environmental benefits through carbon sequestration and generates valuable by products like eco-friendly fuels or fertilizers, fostering healthier, more aesthetically pleasing, and resilient urban environments.

Keywords: The Living Wall; Algae-based Air Purification; AI optimization; Carbon Sequestration

Google's Willow Quantum Chipset: A Comprehensive Analysis of Quantum Error Correction Breakthrough and Competitive Landscape

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ABSTRACT

Google's Willow quantum chip is a significant advancement in quantum computing. It is the first to show below-threshold quantum error fixing (QEC) with errors going down fast ($\Lambda = 2.14 \pm 0.02$ with each step up) and a 2.4x longer life for logical qubits than for physical ones. A look at how it does against IBM Heron, IonQ Forte, and Rigetti shows Willow's better build in quick decoding (1.1 μs), low power use (83 μJ/cycle), and growing speed. Its joint design of hardware and software lets it decode at about 9.1×10^5 cycles per second, key for growing fault tolerance. Even with this growth, beating the tight error limit near 10^{-10} is still a big hurdle to using it widely. This review points to Willow's lead in superconducting quantum tech and its part in the changing world of stable quantum setups.

Keywords: Quantum Error Correction; Surface Code; Superconducting Qubits; Fault Tolerance

Empowering Access to Digital Libraries: A Speech-Driven Search Framework for Inclusive Information Retrieval

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ABSTRACT

As digital libraries become increasingly central to education, research, and lifelong learning, ensuring equitable access for all users is essential. This study presents a speech-driven search framework designed to enhance accessibility in digital library systems by integrating advanced speech recognition and Natural Language Processing (NLP) technologies. The proposed solution combines speech-to-text transcription, semantic query interpretation and adaptive voice feedback to support users with physical, visual or cognitive impairments, as well as those seeking hands-free interaction.

Leveraging deep learning techniques—including Recurrent Neural Networks (RNNs) and transformer-based models—the system achieves high accuracy in understanding diverse accents, languages, and natural language queries. Semantic search algorithms are employed to interpret user intent and deliver contextually relevant results, improving the precision and relevance of information retrieval.

User-centred evaluations were conducted across varied demographic groups to assess usability, effectiveness, and overall satisfaction. Findings indicate that voice-activated search significantly enhances user engagement, reduces accessibility barriers, and fosters greater inclusion in digital knowledge environments. This work underscores the transformative potential of voice interfaces in digital libraries, offering a scalable, user-friendly approach to democratize access to information and support inclusive digital learning ecosystems.

Keywords: Digital Libraries, Speech Recognition, Accessibility, Natural Language Processing

p-Adic Encoding of L-Fuzzy Sets for Sustainable Decision-Making in Uncertain Environments

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ABSTRACT

Fuzzy logic provides a mathematical foundation for handling imprecise information, widely applied in decision-making systems. However, conventional real-valued representations often result in high computational cost and poor symbolic interpretability. This work proposes a novel framework that integrates p-adic number theory into the representation of L-fuzzy sets. Using base-p expansions, fuzzy membership values are encoded as hierarchical sequences, enabling symbolic and multi-resolution approximations.

This p-adic formulation supports coarse-to-fine reasoning and reduces computational overhead, making it well-suited for applications requiring scalable and interpretable uncertainty modeling. Theoretical results on uniqueness, convergence, and truncation error are presented, along with illustrative examples. The model is applicable to sustainable decision systems such as environmental monitoring and adaptive control, where decisions must be made under uncertain or partial information.

Our approach contributes a mathematically robust, compact, and interpretable encoding of fuzzy data that aligns with the goals of sustainable and intelligent decision-making systems.

Keywords: L-fuzzy sets; p-adic numbers; symbolic reasoning; decision systems

Data Mining with Missing Data

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ABSTRACT

Due to missing attribute values data mining algorithms may hamper. Improper handling of missing values can mislead data mining process. Usually there are three methods to handle missing data namely filtering approach, embedded approach and imputation approach. In this paper it has been shown that pre-processing based imputation method is best for handling missing data. It is also shown that for data pre- processing statistical based method, Fuzzy set-based method or Rough set based method can be used. It is also proved that fuzzy-rough hybridization is the best method to handle missing data.

Keywords: Data Mining, Missing Data, Missing value Imputation, Fuzzy-Rough.

Input Impedance of Tunable 45^0-45^0-90^0 Isosceles Triangular Patch Antenna

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ABSTRACT

The triangular microstrip patch antenna is physically more compact than other regular patch geometries with similar radiation characteristics. The isosceles triangular patch antenna can provide better flexibility compared with other triangular patch antennas in the design of microwave integrated circuit. It is a well-known microwave network element due to its widespread application in the design of many useful microwave circuit components. Now, accurate computation of impedance at a particular feed position is very essential to get optimal radiation from any antenna. Here an accurate analytical model based on cavity model analysis has been proposed to compute the input impedance of a tunable right angle isosceles triangular patch antenna (RAITPA). The tunability effect in antenna characteristics is achieved by using air gaps between antenna substrate and ground plane. The effect of air gap substrate on the input impedance has been thoroughly investigated. The accuracy of the present model is computed against the simulated values computed from a commercial electromagnetic simulator. The present model shows very good agreement with the simulated results.

Environmental Sciences

Multi-Elemental Assessment of Soil and Rice Grain in Arsenic-Safe Paddy Fields of West Bengal

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ABSTRACT

Research on arsenic (As) contamination in paddy ecosystems has predominantly focused on high-exposure regions, leaving As-safe groundwater zones relatively underexplored. This work explores the multi-element composition of paddy soil and rice grains from control fields in parts of West Bengal, where irrigation sources consistently fall below national and international As safety limits. Elemental analysis of soil samples showed detectable levels of As along with a variety of trace elements, such as Zn, Cu, Ni, and Cr. Rice grain samples from the same fields were tested for both toxic and essential elements, showing clear patterns in micronutrient uptake and distribution. Interestingly, the cultivated paddy displayed a similar trend in As transfer, from soil to grain, compared to known As-exposed sites, even though the absolute concentrations were lower. This indicates at possible background soil effects, natural sources, or low-level exposure from the environment. The simultaneous profiling of multiple micronutrients also sheds light on nutrient interactions and how efficiently they are taken up in As-free systems. So far, this type of multi-element characterisation in 'safe' zones of West Bengal has been largely overlooked. These findings deepen our understanding of plant and soil interactions with elements and challenge the idea that crops grown in low-risk irrigation areas are free from elemental concerns.

Keywords: Arsenic-safe groundwater; Elemental profiling; Paddy rice; Soil–plant interactions

Arsenic Uptake and Distribution in Wheat (*Triticum aestivum* L.*):* Implications for Dietary Exposure Through Indian flatbread (Roti) Consumption

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ABSTRACT

Wheat (*Triticum aestivum L.*), a major staple crop can also be a potential pathway for arsenic (As) entry into the human food chain when cultivated in As-contaminated soils. This study investigates the uptake and accumulation of arsenic in different parts of wheat plant through its successive growth stages cultivated in As-contaminated soils. Results indicate that although soil arsenic levels were notably high, uptake by the plant was comparatively much lower, particularly in grains. Arsenic concentration was found to be highest in roots, with limited translocation to aerial tissues. Moreover, this study also involves As-exposure through examination of different fractions of Indian flatbread (Roti) during its preparation. Estimated cancer and non-cancer risk through consumption of groundwater in the studied As-exposed population in West Bengal shows that the adult male inhabitants were at higher risk of As exposure compared to female and children. The cancer and non-cancer risk from consumption of roti was found below than the threshold level. These findings suggest wheat plants restricts As mobility within it than other available staple crops and underscore the importance of root-zone monitoring and stage-wise assessment to better understand As dynamics in crops cultivated in affected regions of India. Additionally, the rural population should avoid the As contaminated groundwater used for drinking and cooking purposes to prevent the severe health exposure.

Keywords: Arsenic; Health risk; Transport; Wheat

Phase-Specific Arsenic Accumulation in Mustard (*Brassica* sp.): Insights into Soil to Root Dynamics and Translocation Patterns

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ABSTRACT

Arsenic (As), a toxic and non-essential metalloid, poses a significant threat to agricultural sustainability and food safety, particularly in regions affected by soil and irrigation-based contamination. Mustard (*Brassica* sp.) is notably efficient in As uptake, predominantly through its roots, making it a model crop for understanding As dynamics in edible plants. This study focuses on the influence of root zone soil on As accumulation and its translocation during vegetative and reproductive phases of mustard grown in As contaminated region of West Bengal. Root zone soil, enriched through root-induced biochemical modifications, plays a pivotal role in enhancing As bioavailability. During the vegetative phase, As was largely retained in root tissues, with root concentrations reaching 572 µg/kg, while stem and leaf levels remained considerably lower, suggesting limited mobility and restricted translocation. However, in the reproductive phase, root uptake intensified, reaching 649 µg/kg, accompanied by a marked increase in leaf As content, whereas stem accumulation remained relatively unchanged. This pattern reflects selective allocation of As to metabolically active tissues during reproductive development. The developmental shift in root-to-shoot partitioning underscores the dynamic nature of internal As distribution and highlights the root zone as a critical interface governing plant uptake. These findings emphasize the importance of monitoring As accumulation in edible crops grown in contaminated regions to ensure food safety and guide sustainable agricultural practices.

Keywords: Arsenic; Food crops; Translocation; Soil – plant interaction.

Human–Environment Interactions in the Bengal Dooars Forests: Historical to Contemporary Perspectives

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ABSTRACT

The Bengal Dooars forests, rich in biodiversity and home to diverse ethnic groups, have been shaped by dynamic interactions between human activities such as settlement, migration, and land-use changes, and the natural environment. This study explores the evolving human–environment interactions in the Bengal Dooars, examining not only the impacts of anthropogenic activities but also how local communities have historically adapted to, depended on, and managed forest resources. It analyses key challenges related to habitat fragmentation and loss, human–wildlife conflict, and the prospects for sustainable development. Secondary sources—including historic travel accounts, wildlife hunting records, gazetteers, and forest reports—are used to trace the nature, distribution, and transformation of forests. Census data and spatial data on land use and land cover are analysed to understand demographic changes, migration, resettlement, and shifting land-use patterns that directly or indirectly influence forest dynamics.

The study highlights that in prehistoric and early historic times, indigenous tribes maintained livelihoods closely linked with the forest ecosystem through practices that ensured minimal disturbance. Over time, changing politico-economic contexts—especially during British rule—reshaped this balance by promoting in-migration and clearing forests for plantations and agriculture. In independent India, infrastructure development, forest policies, population growth, modern agriculture, and tourism continue to transform these interactions, posing both threats and opportunities for sustainable forest management and community development.

Keywords: Community, Dooars; Forests; Migration

Monitoring the Status of Small water bodies Using Geospatial Techniques: A Case Study of Barasat Sadar Subdivision, West Bengal (India)

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ABSTRACT

Small water bodies (SWB), like ponds, tanks, beels, reservoirs, canals, etc., play vital role on ecological processes in the riverine environment, performing vivacious functions like water conservation, food supply, cultural value, diverse life forms, pollution abatement, etc. These unique landscape features, despite their great number of occurrences, have received less research attention compared to larger freshwater bodies. Many SWB disappeared during the past century, and existing are increasingly threatened by pollution, urbanization, and agricultural runoff, population growth. Geospatial data are frequently used to detect, monitor and manage water bodies. The recent developments in remote sensing for aquatic environment monitoring are thoroughly reviewed in this study, with a primary focus on inversion models, inversion indices, and remote sensing data sources. This study emphasized the detection of spatio-temporal changes and monitoring of the physicochemical parameters of small water bodies focusing on Barasat Sadar Subdivision, West Bengal. The study employs Google Earth Engine (GEE), Landsat-8 imagery, and high-resolution Sentinel 2 satellite imageries to map and monitor the changes in the areal extent and water quality parameters like Chlorophyll-*a* (Chl-*a*), Total suspended solids (TSS), Turbidity, etc. of small water bodies for the period 2015-2025. The result shows complex biophysical condition, and many water bodies are severely deteriorated. Therefore, for the sustainability of water supplies and ecosystem services in the area, effective legislation, treatment techniques, and monitoring are clearly needed.

Keywords: water bodies, Geospatial techniques, water quality, satellite imageries

Uncontrolled Urban Growth and Environmental Issues: A Case Study of English Bazar Municipality of Malda District, West Bengal.

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ABSTRACT

Unregulated urban expansion poses significant challenges to sustainable development, particularly in rapidly expanding towns and municipalities. This study explores the patterns, drivers, and environmental consequences of unchecked urban growth in the English Bazar Municipality (EBM) of Malda District of West Bengal. Over the last decade, EBM and its adjoining areas have experienced a rapid population growth and unplanned urban development, leading to the encroachment of highly productive agricultural land, deforestation, improper solid waste management, water logging, and increasing air and inland water pollution. The study adopted a mixed-methods approach, combining field surveys, and secondary data to assess land use changes, infrastructural stress, and ecological degradation. Findings disclose that the lack of strict urban planning regulations and weak enforcement mechanisms have contributed to environmental degradation and declining quality of urban life. The paper emphasizes the urgent need for integrated urban management strategies, environment friendly planning and community participation to alleviate the detrimental effects of uncontrolled urbanization in EBM. This case study highlights the broader implications for urban management in emerging towns across India.

Key words: Urban growth, Environmental degradation, Inland water, Ecological degradation.

The Ambivalence of Progress: Tagore's Foresight and the Modern Awareness of the Environmental Catastrophe

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ABSTRACT

In the global scenario, an obsessive and alarming concern is how to balance the scientific developments with the preservation of natural resources. Long before the modern awareness of the climate change and environmental degradation, Rabindranath Tagore had foreseen the environmental problems. At the heart of Tagore's environmental philosophy was a profound reverence for nature. He envisioned the environmental consequences of unchecked industrial and technological advancement. . In an age that increasingly equates advancement with economic growth, urban expansion, and technological application, Tagore perceived that such linear thinking could lead to the disruption of the very life systems that sustain us.

In connecting Tagore's thought to the modern environmental awareness, the paper tries to explore the enduring relevance of his critique and vision for a deeper and holistic awareness of our interdependence with the natural world.

Vanishing Promises: Climate Change and the Silence of Politics in North-East India

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ABSTRACT

India's National Action Plan on Climate Change (NAPCC), launched on June 30, 2008, outlines a strategic framework for addressing climate challenges while promoting sustainable development. Given its ecological vulnerability, North-East India requires targeted and effective mitigation and adaptation strategies. This paper critically evaluates how major political parties in the region integrate climate change concerns within their electoral manifestos and how state governments align policy actions with the objectives of the NAPCC. The study aims to assess the convergence between political discourse and governmental policy regarding climate resilience in the region. Employing an explorative and descriptive research design, the analysis is based on secondary sources using thematic analysis to identify recurring themes, patterns, and the prioritization of climate goals. The findings suggest that climate change remains a peripheral issue in most party manifestos, reflecting a significant gap between electoral rhetoric and actionable commitment. Moreover, only Assam and Tripura have demonstrated moderate progress in implementing NAPCC-aligned initiatives, indicating a fragmented and insufficient policy response in the region. The paper highlights the urgent need for political will and policy coherence to address the escalating climate vulnerabilities in North-East India.

Key Words: NAPCC Goals, Manifesto Promises, Sustainable development, Policy implementation, Environmental governance, Adaptation strategies.

Tiny Troubles: Unravelling Microplastic Mysteries in India's Wetlands and Their Biogeochemical Impacts

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ABSTRACT

Microplastic (MP) contamination has become a widespread environmental hazard, with increasing evidence of its occurrence in marine and terrestrial systems, particularly within the biodiverse and ecologically vulnerable wetlands of India. This work provides a thorough overview of the sources, distribution patterns, and ecological impacts of microplastics in Indian wetlands, a subject that is inadequately addressed in global research. Microplastics, chiefly composed of polyethylene and polypropylene in fiber and fragment forms, arise from anthropogenic activities including sewage discharge and agricultural runoff, as well as natural processes such as air deposition and rainfall runoff. This analysis uniquely emphasizes the biogeochemical dynamics of wetland sediments, highlighting the impact of microplastics on microbial community structures and their role as exogenous carbon sources contributing to greenhouse gas emissions. Moreover, the interactions between MPs and co-contaminants such as heavy metals and endocrine-disrupting chemicals (EDCs) exacerbate ecological and health hazards, including oxidative stress, endocrine disruption, and genetic damage. The novelty of this work lies in highlighting Indian wetlands as both sinks and secondary sources of MPs while advocating for ecosystem-specific risk assessment and mitigation strategies. The findings underline the urgent need for collaborative monitoring, biodegradable alternatives, and region-specific policy frameworks to safeguard wetland biodiversity and public health.

Keywords: Microplastics, Indian wetlands, Ecological risk, Health hazards

Alarming Levels of Microplastic Pollution in North Bengal Rivers: A Hidden Threat to Aquatic Biodiversity and Migratory Bird Habitats in the Mahananda, Teesta (Gajoldoba), and Balason

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ABSTRACT

Microplastic pollution in freshwater ecosystems is an escalating global concern, affecting aquatic biodiversity and posing threats to human health. This study investigates the qualitative and quantitative analysis of microplastics (MPs) in selected stretches of the Mahananda, Teesta (Gajoldoba), and Balason rivers- important water bodies in North Bengal that support both biodiversity and livelihoods. Gajoldoba wetland, a key site for migratory birds, faces increasing stress from tourism-related pollution, including MPs. Water samples were analyzed using ATR-FTIR spectroscopy to detect MPs, and key physicochemical parameters were measured seasonally. ATR-FTIR spectra revealed synthetic polymers such as nylon, polystyrene (PS), polyethylene terephthalate (PET), polyvinyl chloride (PVC), polypropylene (PP), and polymethyl methacrylate (PMMA), indicating widespread contamination. PVC (33.08%) and nylon (22.96%) were dominant in the Mahananda River, while Gajoldoba showed higher PS (29.53%) and PVC (25.13%). In the Balason, PS (38.75%) and PVC (26.75%) were prominent. MPs pose serious ecological risks to aquatic organisms and may disrupt local fisheries. Migratory birds at Gajoldoba are particularly vulnerable to ingestion of MPs, which can lead to both physical blockages and toxicological stress. These findings highlight the urgent need to identify point and non-point sources of MP pollution - such as tourism, urban runoff, and plastic waste dumping- and to develop region-specific strategies for protecting North Bengal's freshwater ecosystems.

Keywords: Microplastics; Polymer Characterization; Freshwater Pollution; Migratory Birds.

Impact of Forest Burning on Soil Physico-Chemical properties and Mycorrhizal Flora in Jhitka Forest, West Bengal, India

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ABSTRACT

Fire represents an ecologically significant disturbance within the forest ecosystem; however the long term impact on soil health and arbuscular mycorrhizal fungi (AMF) remain insufficiently investigated in dry deciduous forest of South West Bengal. This study aims to investigate the ecological impact of fire incidents in the Jhitka forest of Jhargram district, West Bengal. We conducted a comparative analysis of mild burned and severely regular burned forest sites to assess effect on soil physico-chemical properties and AMF spore diversity. Our results indicated that fire significantly altered soil parameters, increasing pH level, while decreasing moisture, water holding capacity and soil macro nutrients like nitrogen, phosphorus and potassium level. Severe burn areas showed a decrease in AMF spore density and diversity, particularly of larger spores. Glomaceae members were noticed dominant across both sites, reflecting its resilience to fire disturbances. Our findings highlight the necessity for site specific restoration measures and the importance of mycorrhizal linkages in maintaining forest ecosystems.

Keyword: Arbuscular mycorrhizal fungi, Dry deciduous forest, Forest fire, Soil Physico-chemical properties.

Impact of Different Biotic Disturbances on Mycorrhizal Associations in Grassland Ecosystems in Lateritic Soil

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ABSTRACT

Arbuscular Mycorrhizal fungi (AMF) are key soil microorganisms that establish symbiotic relationships with plant roots, providing essential ecological services. However, the effectiveness of these mutualistic interactions is frequently compromised by anthropogenic and biotic disturbances like grazing. This study investigates the effects of such disturbances on mycorrhizal associations within different grassland ecosystems in lateritic soil. Four study sites were identified and classified according to disturbance regimes: (1) site with anthropogenic disturbance only, (2) site with both anthropogenic and grazing disturbances, (3) site with grazing disturbance only, and (4) control site characterized by minimal disturbance. Plant root samples were collected from each sites using five 1m ×1m quadrats, and rhizospheric soil sample were collected to analyze the root colonization rates and soil physicochemical properties respectively. Geographical coordinates for each site were recorded utilizing GPS. The results indicated significant variation in colonization rates among the sites, even in same plant species with disturbed sites exhibiting diminished levels of mycorrhizal association. These findings suggest that disturbances adversely affect the ecological functioning of plant-mycorrhizal interactions in lateritic ecosystems.

Keywords: Arbuscular mycorrhizal fungi; biotic stress; grazing; mutualism.

Subsurface Microplastic Pollution and its Ecotoxicological Implications for Aquatic Biodiversity in the River Ganga Ecosystem

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ABSTRACT

The River Ganga, a lifeline for millions in India, faces escalating ecological threats from microplastic pollution. The multiple anthropogenic sources urban runoff, industrial effluents, agricultural practices, and religious activities contribute to microplastic contamination across major cities along the river. Varying concentrations and types of microplastics are found across cities like Varanasi and Kanpur, with seasonal patterns intensifying contamination during monsoons. This pervasive pollution significantly degrades water quality by reducing purity, depleting dissolved oxygen, fostering harmful algal blooms, and clogging waterways and sediments. The ecological ramifications extend to severe impacts on aquatic life, causing physical harm such as gastrointestinal blockages and tissue damage, increasing chemical and metal toxicity through pollutant adsorption, and degrading vital habitats. Endangered species like the Ganges River Dolphin and Gharial face heightened risks due to these pervasive contaminants. Urgent intervention, enhanced monitoring, and sustainable waste reduction are imperative to mitigate this escalating environmental crisis.

Keywords: Microplastic Contamination; Aquatic Biodiversity; River Ganga; Chemical Toxins.

Case Study: Water Quality Assessment of Ichamati River, Bidyadhari River: A Student-Led Investigation into Hardness, Physico-chemical Properties, and Ichamati River Bank Sediment Characteristics

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ABSTRACT

This case study details a comprehensive student-led project investigation of the water quality of the Ichamati River, Bidyadhari River, West Bengal, India. The primary objective is focused on the assessing and comparing water hardness across all sampled locations in different seasons. The analysis mainly employing complexometric analysis as a key quantitative technique. Beyond determination of hardness, river water samples from both Ichamati and Bidyadhari were subjected to further physico-chemical analyses, including pH, viscosity, and surface tension. Another component of the investigation also involved the chemical analysis of sediment collected directly from the Ichamati River bank. This "Experimental Observation Based Learning Theme" provided undergraduate chemistry students with invaluable hands-on experience in analytical techniques.

This experiential learning initiative adopted a deeper understanding of local water bodies, key principles of environmental chemistry, and the broader implications of water quality on regional ecosystems and well-being. The findings revealed seasonal variations in water hardness across the sources. This project's multi-dimensional approach, integrating theoretical knowledge about complexometric titration, pH, surface tension, viscosity with practical skills, demonstrates its high applicability for implementation as an internship or summer project under the National Education Policy (NEP) 2020 curriculum, promoting research-oriented learning.

Keywords: Water Quality, Hardness, Ichamati River, Bidyadhari River, Environmental Chemistry, Soil Analysis, Student Project, NEP 2020, Internship.

A Survey from Chandrakona, Paschim Medinipur District for the Changes in Soil Health during Crop Residue Burning and its Mitigation

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ABSTRACT

Soil health is fundamental to the success and sustainability of farming. It directly impacts crop productivity, farm profitability, environmental sustainability, and the long-term viability of agricultural systems. Burning crop residues can significantly impact soil health in both negative and long-term ways. When crop residues are burned, it disrupts several soil processes, leading to consequences that can degrade soil quality and lead to loss of organic matter, reduction in soil fertility, decrease in soil microbial activity, increase in soil erosion, alteration of soil pH, carbon release which reduced carbon sequestration, air quality issues, long term soil degradation. Rather than burning crop residues, there are several sustainable alternatives that help improve soil health like incorporating crop residues into the soil, composting, mulching etc. Sustainable crop residue management practices focus on enhancing soil health, reducing environmental impacts, and improving long-term farm productivity.

Keywords: Crop residue burning; soil health; air quality issues; sustainable crop residue management.

Harnessing Eco-Tourism Potential in Birbhum District: Pathways to Sustainable Development and Cultural Preservation in Rural West Bengal

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ABSTRACT

Birbhum district in West Bengal, known for its rich biodiversity, tribal culture, historical landmarks, and spiritual significance—highlighted by institutions like Visva-Bharati University—holds immense potential for eco-tourism. Yet, it remains an untapped resource in organized tourism. This study investigates how eco-tourism can drive sustainable rural development while preserving cultural identity. Using a mixed-methods approach, including field surveys, stakeholder engagement, and SWOT analysis, the research evaluates existing infrastructure, community involvement, environmental concerns, and local perceptions.

The findings indicate that Birbhum offers diverse attractions such as nature trails, bird watching, agro-tourism, and cultural festivals, which can be developed without compromising ecological or cultural integrity. However, challenges like poor connectivity, lack of skilled personnel, and limited policy support impede progress. The study advocates for a community-centric, eco-sensitive tourism model to generate livelihoods, promote conservation, and revive local traditions.

Recommendations include public-private partnerships, capacity building, and strategic policy interventions. By aligning tourism with sustainability goals, Birbhum can emerge as a model for responsible tourism in eastern India, demonstrating how integrated resource management can address global challenges through local solutions.

Keywords: Eco-tourism, sustainable development, cultural preservation, Birbhum, rural tourism.

Spatiotemporal analysis of groundwater fluoride contamination and its health impacts on schoolchildren in Murshidabad district, West Bengal, India

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ABSTRACT

Fluoride (F^-) is a toxic pollutant causing chronic exposure through contaminated groundwater. The distribution of fluoride in groundwater across two blocks: Kandi and Khargram in Murshidabad district, in West Bengal which indicates varying levels of contamination. This has raised considerable public health concerns, particularly due to the chronic exposure of local populations through drinking water. Among the most vulnerable groups are schoolchildren, whose fluoridated groundwater intake has been assessed through both water and urinary samples. Elevated urinary fluoride concentrations observed among these children suggest a direct link to fluoride levels in their drinking water, with varying degrees of correlation across different schools in the region. Dental fluorosis has emerged as a prominent health issue among the affected schoolchildren, indicating prolonged exposure to elevated fluoride concentrations. In addition to groundwater, fluoride intake from dietary sources such as vegetables, pulses, and cereals has been evaluated. Certain crops, particularly leafy and non-leafy vegetables, have been identified as significant contributors to total fluoride exposure, raising further concerns about food safety in contaminated areas. The study also included a socio-demographic and economic survey of local communities, which provided valuable context for understanding patterns of exposure and vulnerability. The findings underscore the urgent need for targeted public health interventions and the development of sustainable water quality management strategies in fluoride-affected regions of Murshidabad district.

Keywords: Fluoride, Groundwater, Dental fluorosis, Vegetables

Assessing the Ecological Risk and Bioavailability of Phosphorus through Geochemical Fractionation in Mangrove Sediments of the Western Indian Coast

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ABSTRACT

Phosphorus (P) is one of the vital macronutrient, plays a significant role in the global biogeochemical cycling of distinct biogenic constituents in marine environments. The current study quantify the geochemical fractions, bioavailability, and ecological risk of phosphorus in surface sediment of mangroves, Gulf of Kachchh (GoK). The distribution of sediment P-pools was investigated using a sequential chemical extraction procedure in order to have a better understanding of P dynamics. The results showed that total sedimentary phosphorus varied between 539.51- 7217.24 mg/kg during pre-monsoon and between 487.04- 7180.26 mg/kg in post-monsoon, was found to be predominantly in an inorganic form. Authigenic P and Fe-bound P were the dominant fractions of P in surface sediments, exhibiting a significant long-term P reservoir. The P dynamics in GoK are influenced by a variety of sources, including seaport activities, aquaculture farms, industrial and sewage outflow, and riverine inputs. Besides, OM, pH, ORP, and diagenetic processes have influenced P retention and release. Phosphorus enrichment index showed that sediments were highly impacted by anthropogenic P and could cause a high ecological risk. Bioavailable phosphorus suggest availability of an ample amount of bioavailable P (average of 49.70% post-monsoon and 44.64 % post-monsoon). Sites 3, 13, 14, 20, 21, and 26 exhibited considerably higher BAP. Thus, sediments of GoK could act as a source of P to the overlying water if released from sediments.

Keywords: Mangroves, Phosphorus, Fractionation, Ecological risk assessment

Ecotourism and Sights of Livelihood Resilience in the Wake of Changing Climate: Along the Coastal Belt of Purba Medinipur District, West Bengal

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ABSTRACT

For years, the coastal tourist destination of Purba Medinipur of West Bengal, India is facing the influx of mass tourism. Large flow of tourists in popular destinations of Purba Medinipur is creating a huge pressure on the fragile ecosystem, which are often affected by cyclonic disasters too. Presently, indiscriminate expansion of tourism industry and resultant urbanisation have affected the environmental quality, though at the same time it has ensured that the locals have livelihood options beyond primary sector keeping in mind the continuous climatic hazards they face. Under this circumstance, it is important to examine the possibility of harnessing the potential of ecotourism which can help in increasing livelihood resilience. The study is based on empirical study designed for micro level investigation involving questionnaire survey, taking samples based on stratified random sampling approach comprising of stakeholders like - local residents, local entrepreneurs and tourists. The phase-wise Land Use Land Cover classification of selected areas will determine the occupational shift, increasing urbanization, violation of CRZ - highlighting the areas of concern. Besides, mixed method approach of data analysis will involve statistical findings like factor analysis, perception study and qualitative approaches like Focus Group Discussion and case studies. The SWOT analysis will enable to have a better understanding about the ecotourism ventures promising sustainability and formulate a roadmap of pragmatic tourism policy.

Keywords: urbanization, ecotourism, livelihood, coastal residents

Beyond the Green Revolution: A Case for Indigenous Rice and Agroecological Farming in the Old Alluvium Region of West Bengal, Eastern India

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ABSTRACT

The Green Revolution is widely credited with transforming India's food security through the introduction of high-yielding variety (HYV) seeds, chemical fertilizers, pesticides, and intensive irrigation systems during the 1960s. However, this study argues that the ecological and social costs of the Green Revolution have been significantly underestimated. Drawing on field trials conducted in the Old Alluvium Region of West Bengal, it revisits the potential of traditional rice varieties and documents successful indigenous farming systems that challenge the dominance of HYVs. Specifically, it presents empirical evidence on the performance of Kerala Sundari, an indigenous rice variety, and highlights the advantages of low-input, biodiversity-based agricultural models. Field trials conducted in Kokil Mouza, Harirampur Block, Dakshin Dinajpur District, West Bengal, showed that Kerala Sundari outperformed HYVs in terms of yield, resilience, pest resistance, and soil health under organic farming practices. The study demonstrates that traditional rice varieties, when cultivated using eco-friendly methods, can contribute significantly to sustainable agriculture. It advocates for a shift toward farmer-led, biodiversity-based farming systems to ensure long-term food and environmental security in India.

Keywords: Green Revolution, indigenous rice, food security, ecological degradation, Kerala Sundari, seed sovereignty, sustainability

Assessing Urban Air Quality and Its Public Health Impacts: A Geographical Approach

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ABSTRACT

Urban air pollution has become an increasingly critical environmental and public health issue, especially in rapidly expanding cities across India. This study investigates the spatial dynamics of air pollutants primarily particulate matter ($PM_{2.5}$) and nitrogen dioxide (NO_2) emerging as major threats to public health. Drawing from diverse data sources including the Central Pollution Control Board (CPCB), West Bengal Pollution Control Board (WBPCB), satellite-based remote sensing platforms, academic studies and emerging low-cost sensor networks. Using GIS-based spatial analysis and remote sensing, the study maps concentrations of $PM_{2.5}$ and NO_2 and examines their correlation with unplanned urban growth, traffic congestion, industrial proximity and increased incidences of respiratory and cardiovascular diseases. The findings emphasize that urban form, land-use zoning and transportation infrastructure significantly influence pollution dispersion and population exposure. Areas with inadequate green cover, unregulated vehicular emissions, and poorly planned industrial zones show markedly higher pollutant concentrations. The study further underscores the importance of community-level air quality monitoring systems and spatially informed urban planning as tools for mitigating environmental health risks. This research advocates for a multidisciplinary response to urban air pollution—integrating spatial analysis, public health surveillance, and policy intervention. This study contributes to the global discourse on environmental challenges and demonstrates the crucial role of geographical science in designing equitable and effective public health strategies for sustainable urban futures.

Keyword: Air Pollution, Public Health, Pollution Control, Remote Sensing.

Assessing the Impact of Autorickshaws on Urban Air Pollution in Kolkata: An Analytical Study

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ABSTRACT

Kolkata, one of India's major metropolitan cities, has been witnessing a steady rise in air pollution, with autorickshaws emerging as a significant contributor. This study examines the impact of autorickshaw emissions on Kolkata's ambient air quality, focussing on particulate matter ($PM_{2.5}$, PM_{10}), nitrogen oxides (Nox), and carbon monoxide (CO). The paper tries to measure the contribution of autorickshaw emissions to Kolkata's overall air pollution and to compare the pollution levels in areas with high and low autorickshaw density. The work is based on both primary and secondary data. Data was collected from pollution control board and PVD Kolkata. Survey of autorickshaw drivers was conducted which assessed fuel type, vehicle age and maintenance. Comparative analysis was conducted to identify spatial and temporal patterns. The study is expected to reveal that older 2-stroke autorickshaws running on traditional fuel significantly elevate PM and CO levels, especially in densely populated central and north Kolkata. The introduction of LPG has made this mode of transport one of the cleaner vehicles in the city highlighting a need for more policy interventions targeting emission standards and promoting cleaner alternatives to protect urban health.

Keywords: Autorickshaw emissions, Air pollution, Particulate matter, Sustainable transport

Deforestation and It's Impacts on Humans and Environment

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ABSTRACT

Deforestation has been an issue for decades. It's the clearing, destroying, or otherwise removal of trees through deliberate, natural, or accidental means. Forests, a vital component of life on Earth, cover approximately 31% of our planet's land area. Forests help combat climate change by absorbing carbon dioxide and serve as natural buffers against storms and floods. They are a source of oxygen, food, clean water, and medicine. However, more than 75% of the Earth's surface has been modified and degraded by human activities such as deforestation. According to the secretariat of the UNFCCC (United Nations Framework Convention on Climate Change), agriculture is the root cause of 80% of deforestation. The United Nations Food and Agriculture Organization (FAO) UN Global Forest Resources Assessment, approximately 24.7 million acres of forest are lost yearly, with 95% of this loss occurring in tropical regions such as the Amazon rainforest in South America. Deforestation not only affects the climate by increasing the atmospheric level of carbon dioxide but also affects on human and environment by including loss of biodiversity, changes in climate, health and food insecurity, inhibiting water recycling, triggering severe flooding, soil erosion and disruption of local communities and economies. This paper focuses on studying the impact of deforestation on human and environment, its influence on climate change phenomena.

Key word: Deforestation, climate change, Biodiversity, Environment.

Fluvial Bank Erosion and Channel Migration of the Gomor River in the Part of Gosaba Block, Sundarban

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ABSTRACT

The Indian Sundarban, situated in the southern extremities of West Bengal, represents a biologically intricate and ecologically indispensable landscape. It constitutes the Indian segment of the expansive Sundarbans Delta, a transboundary geomorphic entity shared by India and Bangladesh, globally recognized as the largest contiguous expanse of tidal, halophytic mangrove ecosystem. The objective of this paper is to elaborate the changing scenario of river bank shifting of Gomor river in the part of Gosaba block, Sundarban. The sedimentary architecture of the Sundarban Delta is significantly influenced by regional tectonic activity, coupled with Quaternary and Holocene sea-level fluctuations and associated depositional processes. Since 2012, spatiotemporal alterations in fluvial bank morphology have been rigorously monitored utilizing multi-temporal satellite-based remote sensing datasets, thereby facilitating the precise quantification of lateral erosion rates and geomorphic transformations along the riparian interfaces. This study facilitates the quantitative estimation of fluvial erosion rates along the Gomor River within the selected part of the Sundarban. A suitable bioengineering method has been suggested to build a strong and long-lasting embankment along the river.

Keywords: Geomorphic entity; Spatiotemporal alterations; Lateral erosion; Quantitative estimation.

Food Scarcity and Poverty: A Societal Curse on Nation: A Case Study

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ABSTRACT

The concept of Food Security is multifaceted and varied. It is the measure of the availability of food and the individual ability to procure it. Food is as essential for living as air is for breathing. But food security means something more than getting two square meals. It lies on the three basic concept-availability, accessibility and affordability i,e how much food is produced within a nation; whether the food is equally distributed in all the section of the population irrespective of caste creed; and the dietary food can be purchased by all. According to United Nations' Committee on World Food Security, it is defined as the means that all people, at all times have physical social and economic access to sufficiently safe and nutritious food that meet their food preferences and dietary needs for an active and healthy life. According to UN-India, there are nearly 195 million undernourished people in India, which is a quarter of the world's hunger burden. Also, roughly 43% of children in India are chronically undernourished. India ranks 68 out of 113 major countries in terms of food security index 2022. The present paper is an attempt to highlight the problems created by food security in different parts of the nation and suggest mitigation measures to combat the problem.

Keywords: Food availability; Hunger; Undernourished; Global Hunger Index; Poverty

Greening Growth through Floriculture: Environmental and Socio-Economic Perspectives from Rural Bengal

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ABSTRACT

Floriculture is increasingly acknowledged as a sustainable livelihood option in rural India, offering a valuable synergy between economic development and environmental conservation. This study investigates the role of eco-floriculture in Ranaghat II Block, Nadia District, West Bengal—an agro-ecologically rich region witnessing growing commercial interest in flower cultivation. Positioned at the nexus of rural transformation and ecological stewardship, the research assesses how eco-floriculture can support both livelihood diversification and sustainable land use.

Employing a mixed-methods approach, the study integrates primary data from 160 flower cultivators with secondary sources including FAO, SoilGrids, USGS, and Census data. GIS-based thematic maps—covering slope, elevation, soil pH, and land use—were used to evaluate the physical suitability for cultivation. The analysis also considers cropping practices, input usage, irrigation systems, and marketing strategies, along with the socio-economic profiles of cultivators.

Findings reveal that floriculture enhances household income, facilitates greater participation of women in the agricultural workforce, and promotes diversification away from traditional crops. However, persistent challenges—such as biodiversity loss, pest vulnerability, inadequate storage, and limited knowledge of sustainable techniques—constrain its full potential. Yet, opportunities exist in the form of rising demand for organic produce, farmer training programs, and improved market access.

The study recommends integrated policy action focusing on eco-certification, infrastructure development, and skill enhancement, concluding that eco-floriculture holds transformative potential for inclusive, resilient rural development.

Keywords: Eco-floriculture, Sustainable agriculture, Rural livelihoods, Environmental sustainability.

Echoes of Industry: Tracing the Environmental Footprint of Durgapur

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ABSTRACT

Urbanization and industrial expansion have profound impacts on environmental quality, particularly affecting air, water, and soil. This study investigates pollution levels in Durgapur industrial belt by examining air quality and assessing the physico-chemical properties of soil and water. Water and soil samples were collected from four locations—Muchipara, Palashdiha1, Palashdiha2, and Tamla—while air quality data for Nitrogen Dioxide (NO_2), Sulphur Dioxide (SO_2), and Particulate Matter (PM_{10}) from Angadpur, PCBL More, Benachity, and Bidhannagar were obtained from the West Bengal Pollution Control Board (WBPCB). Seasonal and spatial variations in COD, BOD, and conductivity were observed and found statistically significant ($p < 0.05$), though most parameters remained within Bureau of Indian Standards (BIS) limits. However, air quality emerged as a major concern, with PM_{10} levels (136±36.52 µg/m³) more than double the CPCB threshold of 60 µg/m³. NO_2 concentrations showed sharp fluctuations, while SO_2 stayed below permissible levels. Air Pollution Tolerance Index (APTI) analysis identified *Persicaria sp.* as a pollution-tolerant species suitable for green belt development, and *Persicaria orientalis* as a sensitive bioindicator. The findings underscore the urgent need for stringent emission controls, improved environmental monitoring, and sustainable urban planning to restore ecological balance in Durgapur's industrial region.

Keywords: Air Pollution; Water Pollution; Soil Pollution; APTI

Skies of Colonialism: Climate Engineering as Northern Force, Climate Crisis as Southern Fate

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ABSTRACT

Of yore, the sky was spick and span – just as an infinite expanse of blue canvas, immersed in purity, and festooned in light, where there was no speck of smoke, no stain, no domineering rule, was merely soothing, dotted with stars, transcribed in rhythm, which enchanted every eye. Then ascendancy of empire arose, pursuing storms and mapping winds, probing rains and pacifying storms to explore distant realms. Gradually, the crystal dimmed. The atmosphere turned into an imperial landfill – clogged up with smoke, heat, particles, carbon, and contrails. And within its gloom, the world parted – the North designing its technologies of ambitions, the South suffering the brunt of this indulgence. Centuries goes and colonization re-rose – to dampen heat waves; to curvature sunlight; to orchestrate rainfall, re-engineering this planet in research labs that would reshape it. "*Climate Engineering*", it is dubbed. Yet, to the utmost of Global South, this is no neutral science, beneath its scientific veneer, an echo of atmospheric domination carries a colonial fragrance not by flags, but by invisible formulae. Unveiling the history from a universal element to a armament of geopolitical power, from colonial clouds to carbon governance, from meteorology for trade to the theoretical skies of geo-engineering, this article lays bare path of divergence of the Global North to the South in climate risk management.

Keywords: Imperial legacy; Technological sovereignty; Global environmental injustice; Anthropocene.

Investigation of the acute toxicity effects of paraquat dichloride (PD) toxicity on *Anabas testudineus* (Bloch, 1792).

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ABSTRACT

Paraquat dichloride (PD), a widely used herbicide in agriculture, has raised significant environmental concerns due to its high toxicity. This study investigates the acute toxic effects of PD on the freshwater fish species *Anabas testudineus* (commonly known as the climbing perch), focusing on behavioral and morphological changes. Fish were exposed to five different concentrations of PD and determine the LC_{50} value, calculated using probit analysis. The LC_{50} value was found to be 116.94 mg/L, indicating the herbicide's toxic potential. Exposed fish displayed notable behavioral changes, including nervous system disturbances, heightened stress responses, and difficulty in respiration. Morphological abnormalities were also observed, such as head and tail sclerosis, excessive mucous covering the body, bleeding from gills, reddening of eyes, swelling of the abdomen, redness in head and tail regions, and damaged pelvic and anal fins. These results demonstrate that PD exposure significantly affects the behavior and external morphology of *Anabas testudineus*, emphasizing the herbicide's harmful effects in acute toxicological scenarios. The study highlights the importance of regulating and monitoring PD use in agricultural activities to reduce its negative environmental impacts, especially on aquatic organisms, and to safeguard freshwater ecosystems from potential chemical hazards.

Key words: *Anabas testudineus*, Herbicide, LC50, Morphology, Toxicity

Distribution and path analysis of arsenic in soil, water and rice in certain polluted areas of the lower Gangetic plain in West Bengal

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ABSTRACT

The current study was undertaken to examine the distribution of arsenic in soil, in tube-well water utilized for irrigation, and in rice and the path analysis of available arsenic content in soil and rice grain of four arsenic affected blocks of Nadia district, West Bengal. Approximately 51, 65.7, 59 and 70 per cent soil samples were categorized as low (<5.0 mg kg^{-1}), while 42, 29.3, 39 and 27 percent fell into the medium (5.0-7.5 $mgkg^{-1}$) arsenic category in Chakdah, Ranaghat II, Shantipur and Haringhata block, respectively. The average arsenic content in soils ranged from 4.54 to 5.37 mg kg^{-1}, whereas that in tube-well water ranged from 151.43 to 213.71 µg L^{-1}. The direct effect of available phosphorus on soil arsenic content was the most positive, while iron oxide had the highest negative direct effect on soil arsenic content. Arsenic content in rice shoot had the highest positive and leaf had the highest negative direct effect on grain arsenic content, attributed to the re-translocation of accumulated arsenic from leaf to grain during grain filling stage.

Keywords: Arsenic; rice; soil; tube-well water;

Heavy metals in afforested mangrove sediment: distribution mapping and risk assessment from selected sites of Indian Sundarbans

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ABSTRACT

Mangrove ecosystems are essential to coastal environments because they improve water quality, cycle carbon, reduce soil erosion, protect coastal communities from natural disasters, and foster a variety of biodiversity. Millions of people have benefited from these forests' protection from cyclones and other climate-related disasters, as well as their use as a hotspot for biodiversity and a vital source of income. Due in large parts to their closeness to cities, mangroves are directly impacted by pollution from sewage runoff, agricultural practices, and industrial discharge. Additionally, buried pollutants resurface as a result of other human activities like clearing mangroves for aquaculture, urban expansion, or environmental restoration. These pollutants are released back into the environment when the sediment is disturbed. The current study evaluated the ecological risks, contamination status, and spatial variations of heavy metals (Pb, Cr, Cu, Cd, Mn, Zn) in the ten selected sites of afforested mangrove sediments in different seasons. Heavy metal concentrations followed the order: Mn > Zn > Cr > Cu > Pb. Metal loads, except Cu and Pb, were higher during the dry season. Regardless of season, the sites could be categorized as partially polluted, was indicated by sediment quality criteria, contamination factor, geoaccumulation index, enrichment factors, and pollution load index. All locations have low risk circumstances, according to the potential ecological risk assessment. All metals except lead had a moderate risk of contamination, according to the modified hazard quotient. According to analysis, the majority of the pollutants in the sediment are caused by human activity, specifically sewage water contamination and agricultural runoff. Mangrove habitats may be at risk from continuous metal inflow, even when it was previously uncontaminated.

Key words: Heavy metals, mangrove, mapping, risk, Sundarbans

Understanding the Culture of Environmental Crises: A Safeguard for the Children and the Future

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ABSTRACT

Cultural practices and beliefs that are deeply rooted to the thrust of human existence can influence the communities interacting with their environment, and the ways adopting which, they respond to environmental changes and challenges. Environmental degradation can also lead to the loss of the glory of cultural heritage and the traditional ways of life, further impacting vulnerable communities especially the children in the present context.

The coming together of environmental predicaments and children's comfort and wellbeing is a growing area of concern. Children who are defenceless are disproportionately exposed to the impacts of climate change, including extreme weather events, displacement, and health hazards, while the reality is that they are innocent and least responsible for the calamities. Simultaneously, children's environmental concerns and perceptions are increasingly recognized as crucial for fostering a justifiable future. The present initiative is a drive to make an understanding of this ongoing crises and its impact on the culture and thereby effectively supporting children in channelling their energy into practical environmental actions whilst protecting their wellbeing.

Key words: Culture, environment, environmental challenges, sustainable future

Higher Education Students' Misconceptions on Sustainable Living

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ABSTRACT

This study examines the misconceptions surrounding sustainable living among both undergraduate and postgraduate students within higher education institutions in Kolkata. Employing a mixed-method approach, it reveals the limited comprehension students possess across environmental, economic, and social aspects. These misconceptions frequently arise from disjointed curricula, insufficient experiential learning opportunities, and skewed media representations. The research utilizes a self-made Sustainable Living-Misconception Scale (SLMS), which is grounded in Ajzen's Knowledge-Attitude-Behavior Model, to evaluate conceptual clarity, emotional involvement, and behavioural intentions. A pilot study was conducted to validate and ensure the reliability of the scale (Cronbach's alpha = 0.78; CVI = 0.96). The sample comprised 139 students, chosen through convenience sampling, which provided insights into how socio-demographic variables such as gender, family structure, income, and parental education influence the understanding of sustainability. The results indicated that 46.7% of participants scored below 75 on the SLMS, and they often associated sustainable living to exclusively with environmental issues. Students majoring in social sciences and humanities exhibited narrower conceptions of sustainability aspects compared to their peers in scientific fields. The study recommends strategies such as interdisciplinary education, experiential learning, and collaboration among institutions to rectify these misconceptions. Targeted interventions are designed to equip students with a well-rounded understanding of sustainability and foster action-oriented awareness across various academic disciplines and socio-economic backgrounds.

Keywords: Sustainable Living, Misconceptions, Higher Education, Students

Whey: As an Alternative Cost-Effective Fungal Growth and Fermentation Medium

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ABSTRACT

Whey is the yellowish, creamy liquid separated when milk undergoes coagulation with acid or calcium lactate or enzyme. Cheese whey is one of the suitable substrates for fungal bioconversion due to having high nutrient content. The present study focuses on the preparation of an alternative and cost-effective fungal medium as well as a fermentation medium by using whey obtained from kitchen waste. *Rhizopus oryzae,* which was obtained from okra leaf in our laboratory, was cultivated in whey agar, whereas potato dextrose agar (PDA) served as the control medium. *Aspergillus tubingensis*, another fungus obtained from rotten fruit in our laboratory, and lactic acid bacteria obtained from probiotic capsules were used to ferment whey medium for production of more acid than normal whey medium. Whey medium also helped in congo red (azo dye) discoloration with the help of *Aspergillus tubingensis* efficiently in comparison to potato dextrose broth (PDB) with congo red treated with *Aspergillus tubingensis*. Thus, whey, which can be a byproduct of kitchen waste or the dairy industry, can be used not only as a protein concentrate but also as a fungal growth or fermentation medium. This will definitely help the new age of liquid waste management.

Key words: Whey, fungus, medium, fermentation

Environment and Global Politics

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ABSTRACT

Environment is a precious asset to mankind. There are a variety of issues like climate change, protection of biodiversity, management of natural resources and others which are not limited to any particular country or a group of countries. It is a transnational phenomenon that cut across boundaries and bring the entire global community under its fold. Different initiatives and measures have been taken at the global institutional level to combat the odds that throw a challenge to the environment at large. However, there is an element of politics behind. It is the developed countries or the Global North who in their lust for Industrialization have contributed to turn the environment into a pool of poison. However, the under-developed and the developed countries although being primarily agricultural ones had to bear the burden of the damage caused by the Developed North. Against this backdrop, the paper intends to investigate on the different initiatives taken by the Global Community (Conferences, Summits, Declarations, Agreements, Protocols, Development Goals) for the promotion and protection of the environment and will throw light on the environmental politics that play behind.

Keywords: Environment, politics, sustainability, global communities

DNA Lesions in Fish Erythrocytes as a Versatile Biomarker in Toxicological Research

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ABSTRACT

DNA lesions are the damage or alteration in the structural integrity of DNA of an organism caused by exposure of environmental pollutants or stressors. The wood adhesives can induce DNA lesions (DNA break) in aquatic fauna that gradually leads to severe genotoxic effects. The DNA lesions are formed either by direct exposure of chemicals with DNA (direct method) or by the formation of reactive oxygen species (indirect method). The assessment of structural changes or DNA strand breaks is very crucial in ecotoxicology as it indicates the potential genotoxic effects due to chemical contaminants. In addition to that, the detection of DNA damage contributes the vital information on overall toxicity impact of pollutants on ecosystem. The DNA lesion in fish can be detected by employing comet assay (single cell gel electrophoresis) method. Since the fish inhabiting in the water column, any changes occurred in the physical parameters of the water content directly reflected on the fish erythrocytes and also caused detrimental effects in the fish health status. The purpose of this study was to investigate the chronic genotoxicity by measuring the DNA lesions due to wood adhesives on *Etroplus suratensis* by static renewal bioassay method. The result of the study showed that green chromide elicited an intensified DNA lesions in concentration and duration of exposure of wood adhesive.

Keywords: DNA lesion, comet assay, static renewal bioassay, *Etroplus suratensis*

Decadal Change in Surface Water Quality Status of the Hooghly River

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ABSTRACT

Rivers are indispensable for life, serving as primary sources of drinking water and crucial for both industry and agriculture. Hooghly River, a vital distributary of the Ganga, serves as a lifeline for Bengals population and industrial activities. This study aims to highlight the decadal changes in the surface water quality status of the Hooghly River, specifically assessing its suitability for irrigation. Data on water parameters over a ten-year period were collected from the WB Pollution Control Board from two centres of Hoogly river- Gardenrich and Daskhineswar. To evaluate the Hooghly River's irrigation suitability, different Irrigation Water Quality Indices (IWQI) were calculated like Sodium Adsorption Ratio (SAR), Soluble Sodium Percentage (SSP), Residual Sodium Carbonate (RSC), Residual Sodium Bicarbonate (RSBC), Magnesium Hazard (MH), Permeability Index (PI), Potential Salinity (PS), and Kelley's Ratio (KR). The water quality analysis revealed significant decadal shifts. At Garden Reach, SAR, Na%, SSP, PI, and KR showed increases between 2013 and 2023 across pre-monsoon, monsoon, and post-monsoon seasons, while RSC, RSBC, MH, and PS consistently decreased. Similar trends were observed at Dakshineswar. Interestingly, a marked improvement in water quality was noted in 2020, particularly during the pre- and post-monsoon seasons, at both stations which maybe correlated with reduced industrial, transportation, and human activities during the COVID-19 lockdown period. This study can offer crucial insights for policymakers, guiding them toward more sustainable management of the Hooghly River's surface water.

Keywords: Hoogly River, Irrigation Water Quality Index (IWQI), Decadal Water Quality Trends, COVID-19 Lockdown Impact

India's Environmental Governance: Dealing with Cruxes, Responsibilities and Scopes

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ABSTRACT

India maintains a cordial balance between its rich traditional heritage and modernity without negatively impacting the environment. But she also feels that technological advances alone or smart governance alone may not be able to solve the fundamental problem that environmental governance must address. While environmental governance is becoming more comprehensive, it is clear that the path and pace of development are constantly redefining the problems it faces. Thus, the present paper is going to highlight the aspects of India's environmental initiatives at governmental level in respect to various issues, liabilities and objectives.

Key words: Environment, governance, fundamental problem, development

Attitude of Hindustani Raag Sangeet System towards Monsoon: The Seed of Philosophy of Water Conservation and Sustainability in Society

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ABSTRACT

Water, the matrix of life is valued since ancient times in India. People congregated enormous traditional knowledge to manage water resource, at the same time they offered high honour and profound love to it. One form of this appraisal, respect and adoration of society to rain as well as water resource is the way of perception, celebration and appreciation of monsoon, a major form of water resource, in Hindustani Raag Sangeet system as India's entire economy depends upon the timely arrival of monsoon. To admire monsoon, the Hindustani system has a distinctive heritage of Monsoon songs which spans numerous monsoon raags such as 30 types of Malhar; Megh Malhar is associated with advent of monsoon, Mian ki Malhar with unremitting rains, Gaud Malhar played amid well advanced playful monsoon, and Surdasi Malhar at the end of the season. Varieties of Malkauns, varieties of Sarang such as Vrindavani Sarang, Goud Sarang, Baro Hansa Sarang, Miyan Ki Sarang, Jaijaiwanti, Bhairavii *etc.* are other raags to venerate monsoon and to address different psychic states of Indian soul articulated in rains and its effect on biodiversity (flora and fauna). In dry parts of the country such as Rajasthan the music discipline is associated to inviting rain, rain water harvesting and fetching water. This attitude of the Hindustani system depicts the sense of gratitude towards nature as well as water resource; this sense is the seed of philosophy of water conservation and management.

Key words: water resource, Hindustani Raag Sangeet system, monsoon raags, water conservation

Delineating Groundwater Potential Zones in Purulia District, West Bengal: A Geospatial Approach

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ABSTRACT

Groundwater scarcity is a significant issue in the Purulia district of West Bengal, an area characterized by a hard rock terrain and a semi-arid climate. This paper outlines a study with a dual objective: to investigate the primary causes of this water crisis and to delineate the geographical zones of poor groundwater storage using Remote Sensing (RS) and Geographic Information System (GIS) techniques. The investigation into the cause points to a combination of natural and anthropogenic factors. Geologically, the district is dominated by crystalline rocks with low porosity and permeability, severely limiting natural groundwater recharge. This is exacerbated by erratic and low average annual rainfall, leading to high runoff and minimal infiltration. Over-extraction of groundwater for agricultural and domestic needs further depletes the already stressed aquifers. To achieve the second objective, this study will employ RS and GIS-based methodologies. Thematic layers such as lithology, geomorphology, lineament density, slope, drainage density, and land use/land cover will be generated from satellite imagery and topographical maps. These layers will be integrated and assigned weights using the Analytical Hierarchy Process (AHP) in a GIS environment to create a comprehensive groundwater potential map. This zonation will identify and demarcate areas with poor to very poor groundwater storage, providing a crucial tool for implementing targeted and sustainable water resource management and conservation strategies in the Purulia district.

Key words: Groundwater Potential, Purulia, RS & GIS, AHP (Analytical Hierarchy Process)

Contributors to the Atmospheric Methane Gas Cycle in India Over Thirteen Years

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ABSTRACT

Thirteen years of atmospheric methane fluctuations over India (GOSAT data) has been analyzed using a novel Hilbert Huang Transformation methodology. Decomposition of the time series into intrinsic mode functions reveals several cyclic components embedded in the data. Different characteristic time scales of the intrinsic mode function (IMF) show various methane emitting sources contributing to atmospheric methane over India. Fluctuations of CH_4 observed in each intrinsic mode function reveal highest CH_4 emission during and at the end of annual monsoon period i.e. June to September. Methane emissions from biogenic sources are attributed to this large fluctuation. Comparison of results with EDGAR data further strengthened that emission from rice cultivation and biomass burning contributed to the observed variation in IMF5 and the variation observed in IMF6 can be attributed to the emission from biofuels used in residential settings. Residue obtained after the decomposition process, show an increasing trend of atmospheric methane concentration. Comparison with EDGAR data show that emission from waste water treatment, solid waste disposal, enteric fermentation and manure management could have contributed to the observed trend.

Keywords: GOSAT Atmospheric CH_4 in India, Hilbert Huang Transformation, CH_4 cycle, EDGAR database

Nanobiofertilizer: An Innovative Approach in the Field of Agriculture

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ABSTRACT

Agriculture is the major backbone of human evolution as it has been considered from the very early period of human civilization. The increasing demand for food has been mitigated to enhance crop productivity by the use of chemical fertilizer. Our environment as well as crop quality have been largely affected by the abrupt use of chemical fertilizer. Biofertilizers have been introduced into the field of agriculture to overcome the hazardous side effects of chemical fertilizer. But, the small shelf-life and target-specificity of biofertilizers led to the development of nano-biofertilizers. The nano-biofertilizer is a successful outcome of the hybridization of nanoscience and biotechnology. The use of nano-biofertilizers has been gaining more importance nowadays because of its potential to enhance soil quality, plant growth and crop production. Doping nano-particles into biofertilizers increases the longevity, stability & efficiency of biofertilizers by several folds. It has been synthesized by the combination of a variety of microorganisms with nanoparticles. Still, it also has some adverse effects relating to the toxicity of the nano particles on the environment. The synthetic process, method of application, mode of interaction with plants, application in agriculture, advantages, disadvantages and future aspects of nano-biofertilizers are highlighted in this aspect.

Keywords: Agriculture; Biofertilizer; Microorganisms; Nano-biofertilizer.

Dirty Deals: Spatio-Temporal Analysis of Environmental Brown Crimes in India

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ABSTRACT

Environmental criminology is a growing field that examines the legal framework and deficiencies in environmental protection systems. "Brown criminology" within this area specifically addresses environmental issues, particularly air and water caused by urbanisation, Industrialisation, and mismanagement of the waste management system. In India, rapid urbanization and population growth have led to significant degradation of the environment in recent years, as reflected in regular data on water and air pollution levels recorded by central and state pollution control boards. The Air and Water Pollution Prevention Act has been established, and a strict penalty system is outlined in the IPC. Additionally, environmental crimes are recorded annually by the National Crime Records Bureau to monitor the situation. The main goal of this paper is to analyse the spatiotemporal patterns of various environmental crimes across states and Union territories using this data in last five years, and to examine their association with existing favourable conditions of committing crime such as the availability of forests and water bodies (suitable target), the number of pollution-causing industrial firms, urban population density (motivated offenders), and the current pollution monitoring system of the pollution control boards (absence of guardian) following the routine activity theoretical framework of crime.

Keywords: Environmental criminology, Brown crime, Air pollution, Water pollution, Routine Activity Theory.

Sustainable E-waste management in Raniganj coal town, West Bengal

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ABSTRACT

Raniganj, designated as Borough-II under the Asansol Municipal Corporation in Paschim Bardhaman, is situated between West Bengal's second-largest urban agglomeration and the industrial hub of Durgapur Steel City. This historic mining town is currently experiencing significant demographic stress, with escalating population density and rising resource demands. The concomitant surge in consumption has precipitated a marked increase in electronic waste generation, which necessitating urgent attention toward sustainable waste management solutions. Effective e-waste management has emerged as a critical imperative to address both immediate environmental concerns and long-term ecological vulnerabilities. This study encompasses a comprehensive evaluation of stakeholders, including academic institutions, healthcare facilities, governmental bodies, non-governmental organisations, and private sector entities. Advanced statistical analyses integrated with Geographic Information System techniques were employed to assess e-waste generation patterns and evaluate sustainable management practices within the source region. The heterogeneous distribution of e-waste and the inadequacy of current mitigation strategies underscore the complexities of waste governance. To mitigate these challenges, we propose an optimised management framework aimed at ensuring sustainable handling of this escalating environmental burden. The REWM pathway from source to disposal system has been strategically designed to optimise both immediate and long-term solutions for sustainable environmental management, leveraging indigenous mechanisms.

Keywords: E-waste; GIS; Sustainability; REWM

Material Sciences and Nanosciences

Magnetically Retrievable Nanocatalyst for the Green Synthesis of Paracetamol

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ABSTRACT

N-Acetyl-para-aminophenol, also known as paracetamol, was first synthesized in 1878 and widely marketed as a painkiller and fever reducer. Not only that, it is one of the most consumed drugs, having a global production of more than 200,000 tons per year and a market value of over 1 billion USD by 2022. Under these circumstances, the development of a sustainable protocol for the synthesis of paracetamol is highly desirable.

Fe_3O_4 nanoparticle was synthesized by the reaction between $FeCl_2$ and an ammonical solution of p-nitrophenol. Pd was embedded into the nanoparticle so that it can be used as a magnetically retrievable catalyst.[2] This hybrid catalyst was successfully utilized in the synthesis of paracetamol in a one-pot reaction with high yield and efficacy within a short time, demonstrating that the nano catalyst offers advantages in the synthesis of drug leads for industrial purposes.

Keywords: Nano catalyst; Green synthesis; Paracetamol production.

Engineered Improved siRNA Therapeutics against Metastatic Breast Cancer

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ABSTRACT

RNA interference-based therapeutic gene silencing is an emerging platform for managing highly metastatic breast cancer. Cytosolic delivery of functional siRNA remains the key obstacle for efficient RNAi therapy. To overcome the challenges of siRNA delivery, we have engineered a vitamin E-tethered, short, optimum protease-stabilized facial lipopeptide-based non-immunogenic, biocompatible siRNA transporter to facilitate clinical translation in the future. Our designed lipopeptide has an Arginine-Sarcosine-Arginine segment for providing optimum protease-stability, minimizing adjacent arginine–arginine repulsion and reducing intermolecular aggregation, and a-tocopherol as the lipidic moiety for facilitating cellular permeabilization. Interestingly, our designed non-immunogenic siRNA transporter has exhibited significantly better long-term transfection efficiency than HiPerFect and can transfect hard-to-transfect primary cell lines, HUVEC. Our engineered siRNA therapeutics demonstrated high efficacy in managing metastasis against triple-negative breast cancer by disrupting the crosstalk of endothelial cells and MDA-MB-231 and reducing stemness and metastatic markers, as evidenced by downregulating critical oncogenic pathways. Our study aimed at silencing Notch1 signalling to achieve "multi-targeted" therapy with a single putative molecular medicine. We have further developed a mechanistically rational combination therapy combining Notch1 silencing with a repurposed drug, m-TOR inhibitor, metformin, which demonstrated synergistic interaction and enhanced antitumor efficacy against cancer metastasis.

Keywords: siRNA transporter; gene silencing; combination therapy; triple negative breast cancer.

Framing the Features of Magnetic Induction in Bioconvection Flow of Nanofluid Comprising Gyrotactic Microorganisms: A Biomedical Approach

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ABSTRACT

The present article is concerned with bioconvection of gyrotactic microorganisms over a permeable surface in water-based nanofluid in the presence of magnetic induction. Flow is considered steady and incompressible. We carried out the analysis of heat transmission in the flow through thermal convection, whereas mass transmission through a binary chemical reaction. Flow analysis is performed under the Stefan blowing effect. Consequences of thermophoretic diffusion and Brownian motion are taken into account. We renovate the primary PDEs of the acknowledged flow model into ODEs by employing a similarity transformation. The consequential ODEs are resolved by the shooting procedure by inducing a Runge–Kutta–Fehlberg fourth-fifth order scheme. The recognized outcomes are novel and unique. The greatest attractive applications accompanying Bioconvection of gyrotactic microorganisms comprised the engineering science, society, and the industry, like medicine production, microsystem, daily food, chemical industry, bio-microsystem, and bio-medical applications, etc.

Keywords: Bioconvection; Nanofluid flow; Gyrotactic Microorganisms; Induced Magnetic Field.

Electronic and Optical Signatures of Synthesized 6,6,12-Graphyne Fragments: A DFT-Based Study

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ABSTRACT

6,6,12-Graphyne, a carbon-based material with rectangular symmetry, stands out for its unusual Dirac fermion behavior and highly directional charge transport. In this study, we use first-principles calculations to analyze the structural, vibrational, and optoelectronic properties of recently synthesized molecular fragments of this material—namely, radiaannulene-based oligomers (O1–O6). Our results show that the Raman spectra of these fragments feature distinct signals from both sp and sp^2 hybridized carbon atoms. These vibrational modes shift systematically with oligomer length, making them useful markers for assessing polymerization. The relative stability of various oligomers is confirmed by theoretical estimations of cohesive energy, which show a good correlation with experimental synthesis yields. O4 is the most advantageous oligomer. Electronic structure calculations reveal tunable energy gaps within the visible spectrum. Time-dependent DFT simulations reproduce observed absorption peaks and also uncover strong nonlinear optical activity, particularly in O3 and O6. Direction-dependent optical properties—such as dielectric response and energy loss behavior—highlight significant anisotropy and extended π-conjugation. Among the studied systems, O6 closely mirrors the behavior of an extended nanoribbon, suggesting it effectively captures bulk-like features at the molecular level. This work provides a thorough theoretical framework that enables the incorporation of 6,6,12-graphyne oligomers into upcoming nanoelectronic and photonic technologies and is consistent with experimental results.

Keywords: 6,6,12-Graphyne Oligomers, First-Principles Calculations, Raman Spectroscopy, Optoelectronic Properties

Exploration of Magnetic $Ni_{0.5}Zn_{0.5}Fe_2O_4$ Solid Microspheres as Electrode Material for Advanced Supercapacitor Applications

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ABSTRACT

A facile, one-pot solvothermal technique has been adopted to synthesize self-assembled hierarchical solid microspheres of $Ni_{0.5}Zn_{0.5}Fe_2O_4$ for advanced supercapacitor applications. Powder X-ray diffraction (PXRD), field emission scanning electron microscopy (FESEM), energy dispersive X-ray spectroscopy (EDS), Fourier Transform Infrared (FTIR), and BET surface analysis have been adopted to characterize the sample. The PXRD study revealed the formation of a pure cubic spinel structure of the synthesized sample having Fd-3m symmetry. The microspheres of average diameter ~221 nm, composed of nanoparticles of average particle size ~13 nm, are estimated from FESEM micrographs, and the surface area is 21 m^2g^{-1} determined from BET surface analysis. The dc magnetic study of the sample demonstrates its magnetic ordering at lower temperature with superparamagnetic behavior at room temperature, depicting saturation magnetization of ~ 103 and ~ 74 emu g^{-1} at 5 K and 300 K, respectively. Electrochemical performance of the sample has been investigated using three electrode system by cyclic voltammetry (CV) and Galvanostatic charging-discharging (GCD) techniques in 1 M KOH electrolyte, demonstrating a high specific capacitance of 1032 Fg^{-1} at 5 mVs^{-1} potential scan rates along with capacitance retentivity of 92% even after 5000 GCD cycles. These results highlight the potential capability of $Ni_{0.5}Zn_{0.5}Fe_2O_4$ solid microspheres as a promising electrode material for next-generation high-performance supercapacitor applications.

Keywords: Spinel Ferrite; Solvothermal; Microspheres; Supercapacitor

Exchange Bias and Magnetic Memory in $YCrO_3$- $CoFe_2O_4$

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ABSTRACT

This investigation examines the origin and manifestation of the exchange bias (EB) phenomenon and magnetic memory effect within nanocomposite $YCrO_3$-$CoFe_2O_4$, utilizing diverse protocols dependent on time (t) and temperature (T). Synthesis of the composite nanoparticles employed the conventional sol-gel technique. Comprehensive characterization of the as-synthesized sample was performed using powder X-ray diffraction (PXRD) and transmission electron microscopy (TEM) studies, which clearly revealed crystallite and particle sizes measuring 31.24 nm for $YCrO_3$ and 15.01 nm for $CoFe_2O_4$. Analysis of the thermal variation of magnetization [M(T)] indicates the formation of a canted antiferromagnetic (AFM) ground state, characterized by magnetic transitions occurring near 140 K. Below this Néel temperature, a significant exchange bias effect (with an EB field (H_e) of 300 Oe measured at 3 K after cooling in a 1 kOe field) was conclusively demonstrated by the observable shift in the magnetic hysteresis (MH) loop following field-cooling procedures (H_{cool}= ± 30 kOe). This exchange interaction fundamentally stems from the competitive interplay between antiferromagnetic and ferromagnetic ordering present at the interfaces. Furthermore, the emergence of a super-spin glass (SSG)-like state, driven by finite size effects and robust dipolar interactions within the nanoparticle assembly, clearly manifests the memory effect observed in M(T) measurements under both field-cooled (FC) and zero-field-cooled (ZFC) protocols, as well as through isothermal remanent magnetization (IRM) mechanisms.

Keywords: sol-gel, exchange bias, magnetic memory

Electronic Transport through S-Prophyrin and P-Porphyrin Nanoribbon: A DFT Study

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ABSTRACT

The electronic transport properties of P-porphyrin and S-porphyrin nanoribbons have been investigated using the nonequilibrium Green's function (NEGF) formalism combined with density functional theory (DFT). Band structure calculations reveal that both nanoribbons exhibit metallic behaviour. Under extremely low bias, they demonstrate metal-like conduction. A pronounced negative differential resistance (NDR) effect is observed in both systems, which is attributed to the evolution of transmission peaks within the energy bias window (EBW) and the overlap of electronic states between the left and right electrodes. This low-bias NDR behaviour suggests that the proposed nanoribbon-based devices hold promise for applications in NDR-based technologies such as frequency multipliers, memory elements, and high-speed electronic switches.

Keywords: NDR; Transport; NEGF; Nanoribbon.

Zinc Nanoparticles and its Antimicrobial Efficacy

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ABSTRACT

Nanoparticles are extremely small particles, typically ranging from 1 to 100 nanometers. One of the most effective and helpful ways to overcome microbial resistance to antibiotics is the use of oxides from metal nanoparticles and as well as their oxides. Zinc oxide nanoparticles are one of the most widely used nanoparticulate materials due to their antimicrobial properties. ZnO-NPs are rod-shaped, and their characterization through X-Ray diffraction, FTIR Spectroscopy, SEM, Disc diffusion technique, etc. ZnO-NPs can be found by different methods, resulting in nanoparticles with various sizes and morphologies, which affects their antimicrobial potential. The mini review tells an analysis of the results of studies in recent years aimed at studying the antibacterial activity or effect of the applied nanoparticles in relation to many bacteria, such as *Pseudomonas aeruginosa, Staphylococcus aureus, Escherichia coli,* and other bacteria. It can help in the prevention or precaution against bacterial effects.

Keywords: nanoparticles, zinc oxide, antibacterial, SEM.

An Eco-Friendly Technology Based on Radiation Processed Model Hybrid TPE Nanocomposites: Emerging Trends & Benefits

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ABSTRACT

Polymer nanocomposites (PNCs) have long been studied for their potential to enhance polymer performance and expand applications. Their nano-scale structures impart unique properties, enabling the design of polymers with desired properties. Controlled irradiation can potentially be an effective way of tailoring the technical properties of such PNCs. This article explores the selective modification of a model thermoplastic elastomer (TPE) blend (LDPE/EVA) using modified and unmodified nanosilica fillers, combined with Electron Beam (EB) processing at a very controlled dose level. The nanosilica particles were melt-blended into the TPE system with varying contents and addition sequence. The blends were compression molded and analyzed for morphological, mechanical, and thermal properties. All nanosilica-based films show notable improvements in mechanical and thermal properties, strongly influenced by silica loading and controlled irradiation. Morphological analysis reveals that modified nanosilica disperses uniformly in the polymer matrix, leading to strengthening of the silica-polymer interface. Notably, the addition sequence has minimal impact post-modification. Overall, although the properties of the unmodified nanosilica-filled films strongly depend on the addition sequence but, interestingly, modified nanosilica-filled samples show minimal sensitivity to the preparation method. EB irradiation induces a high degree of reinforcement in all the unmodified silica-filled samples, whereas modified silica-loaded samples show little improvement. Finally, this green technique studied can be potentially extended for the improvement of the technical properties of conventional TPE systems.

Keywords: Thermoplastic elastomer; Silica nanoparticles; Radiation crosslinking; Reinforcement.

Neural Network-Based Analysis of Microbial Dynamics in Magnetized Nanoparticle-Enriched Fetal Bovine Serum Around a Rotating Sphere

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ABSTRACT

This work investigates artificial neural networks (ANNs) by employing the Levenberg-Marquardt backpropagation to simulate the bioconvective unsteady flow in the stagnation region of a revolving sphere in the presence of a magnetic field. Bioconvection combined with silver and iron oxide nanoparticles plays a crucial role in biomedical transport, targeted drug delivery, and wastewater treatment. This study incorporates the radiative heat flux, viscous dissipation, mass suction, and Arrhenius activation energy. Both the free-stream velocity and the angular velocity of the sphere are supposed to be time-dependent. Similarity transformations are used to convert the fundamental unsteady equations into a dimensionless form. Numerical computations are carried out in *MATHEMATICA* via a shooting technique coupled with a fourth-order Runge-Kutta (RK4) integration scheme, providing detailed insights into velocity components, temperature, concentration, microorganism density, along with critical engineering parameters. Results reveal that increasing the magnetic parameter reduces the z-direction velocity component due to Lorentz force effects, while enhanced thermal radiation raises temperature profiles and thickens the thermal boundary layer. Application of a magnetic field increases the Nusselt number by approximately 95.52%, exhibiting an almost perfect linear correlation with a regression coefficient of 0.99967. This study establishes a framework for advanced biomedical applications requiring precise microenvironmental control.

Keywords: Bioconvective unsteady flow; revolving sphere; fetal bovine serum; AI algorithms.

Perovskite Materials for Supercapacitors: A Comprehensive Review of Structure, Performance, and Future Prospects

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ABSTRACT

The supercapacitor has unique and adaptable properties compared to conventional energy storage devices. A supercapacitor's capacitance, energy, and power density dictate how it functions. Discussed the comparison between lithium-ion batteries and supercapacitors and the electrochemical parameters of supercapacitors. Electric double-layer capacitors (EDLCs), pseudocapacitors (PCs), and hybrid capacitors are the three categories of supercapacitors that are distinguished based on energy storage mechanisms. Examine several kinds of perovskite materials for the electrodes of supercapacitors. Study several methods for synthesizing the perovskite electrode materials for supercapacitors. Examining the surface morphology of several kinds of reported perovskite electrodes using SEM images. Utilizes CV, GCD, and EIS analysis to examine the electrochemical characteristics of comparable electrodes. This chapter has presented a comparative analysis of the electrochemical characteristics of several perovskite materials.

Keywords: Energy Storage; Supercapacitor; Perovskite Materials; Synthesis Methods; Surface Morphology, Electrochemical Performances.

A Study of Additively Manufactured Ceramic Materials

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ABSTRACT

Ceramic materials are extensively employed across diverse engineering sectors owing to their exceptional mechanical, thermal, and chemical attributes. This review article examines the current advancements in the processing of ceramic-based materials with intricate geometries utilizing principal additive manufacturing (AM) techniques. By doing so, the production durations and costs of ceramic-based AM components with specified properties can be significantly diminished. Nevertheless, conventional manufacturing methods often encounter substantial challenges such as complexity in producing intricate shapes, prolonged processing durations, elevated levels of porosity, and pronounced deformations induced by shrinkage. The investigation delves into pivotal factors influencing the quality and functionality of ceramic elements. Furthermore, the discourse on ceramic additive manufacturing encompasses feedstock preparation and properties, interactions between laser and material, formation and regulation of defects, quality of shaping and microstructure, as well as management of porosity and shrinkage to ensure the fabrication of high-performance components. The article underscores extant obstacles and offers insights into future research avenues, aiming to expedite the advancement of more dependable and efficient processes for ceramic materials in sophisticated engineering applications. Initially, a systematic summary of the diverse procedures involved in additive manufacturing and ceramic materials production is provided. Subsequently, the introduction of ceramic additive manufacturing technology is outlined. Lastly, the technical challenges and prospective research directions related to additively manufactured ceramic materials are deliberated.

Keywords: Ceramic Materials; Additive Manufacturing; Material Properties; Defects.

Magnetic Phase Transition in Cr (001) Ultrathin Films: A Thickness-Dependent Photoemission Study

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ABSTRACT

The electronic configuration of the Cr atom ($[Ar]3d^5 4s^1$) favours a giant enhancement of its magnetic moment upon isolation. Bulk *bcc* Cr is a weak antiferromagnet, featuring an incommensurate spin density wave with magnetic moment 0.59 μ_B per atom. On the other hand, a freestanding Cr monolayer demonstrates a magnetic moment of 4.45 μ_B per atom and forms a commensurate antiferromagnetic ordering upon stabilization over suitable substrates. A thickness-dependent study of Cr (001) ultrathin film is therefore worthwhile to investigate the magnetic phase transition. Cr (*l.c.* 2.88 Å) grows pseudo-morphically on Ag (001) crystal (*l.c.* 4.09 Å) with a 45^0 rotation of the surface unit cell. Cr was evaporated to deposit on an Ag (001) substrate at 428 K using standard molecular beam epitaxial growth. The thickness of the film was estimated *in situ* using a pre-calibrated quartz microbalance and ascertained by X-ray photoemission spectroscopic quantification. Low-energy electron diffraction pattern indicated the epitaxial quality and the surface crystalline symmetry directions. Moreover, the presence of *c(2x2)* fractional ordered, exchange scattered, low intensity spots within 20-40 eV beam energies implies a commensurate, long-range AFM ordering around monolayer Cr coverage. Valence bands probed by angle-resolved photoemission using monochromatic He I_α (21.2 eV) and He II_α (40.8 eV) sources reveal significant modifications of Cr 3d band dispersions with film thickness variation, confirming magnetic phase transition from monolayer to higher Cr thickness.

Keywords: Ultrathin films, Surface magnetism, Low energy electron diffraction, Photoemission spectroscopy.

Oxidation of W(110) during Cleaning

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ABSTRACT

One of the most popular substrates for thin film formation is the densely packed (110) surface of tungsten because it has the highest melting point of any metal (3683 K) and is brittle and hard, especially when impurities like carbon and oxygen are present. In comparison to other metal substrates like Ag(001), Ag(111), the cleaning of W(110) is more challenging since it contains carbon and oxygen. Carbon from the bulk is segregated onto the crystal's surface by annealing it at a very high temperature. This is typically followed by oxygen annealing and flash at high temperature that extracts carbon as CO and CO_2. However, tungsten oxide production was seen during cleaning, as evidenced by the low-energy electron diffraction (LEED) pattern resembling twin domain tungsten oxide (WO_2). The domain is extremely similar to the (1×1)×12 LEED pattern and may be described in matrix notation $\begin{bmatrix} 0 & 9 \\ -2 & 5 \end{bmatrix}$. Oxygen annealing temperature, partial pressure, flash temperature, and duration can all have a significant impact on how the cleaning process turns out in the end. By oxygen annealing at five different pressures, ranging from 1×10^{-6} mbar to 7×10^{-8} mbar, for thirty minutes at a time, a final clean surface was achieved. The flashing process lasted just 5–10 seconds at a temperature higher than 2373 K.

Keywords: Surface oxide, Surface structure, LEED;

Sodium Induced Modification of Microstructure and Magnetic Ordering in $NdMnO_3$

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ABSTRACT

Perovskite structured $NdMnO_3$ compound suffers inherent structural distortions like tilting of MnO_6 octahedra and Jahn-Teller distortion, which can be modified by doping in the place of Nd. In this work, we have studied the effect of monovalent sodium dopant on structural distortion and magnetic ordering of $NdMnO_3$. $NdMnO_3$ and $Nd_{0.85}Na_{0.15}MnO_3$ compounds were prepared by the conventional sol-gel route. Both compounds are crystallized in an orthorhombic unit cell with the P_{bnm} space group. Unit cell volume is found to be decreased after Na doping, which results from shortening of Mn-O bond lengths. 15% Na doping results in 30% conversion of Mn^{+3} into $Mn^{+4,}$ which reduces Jahn-Teller distortion. As the ionic radius of dopant Na^{+} (1.39Å) is greater than the parent Nd^{+3} (1.27Å), doping increases the Goldschmidt tolerance factor from 0.89 to 0.895. The average Mn-O bond length reduces from 2.03 Å (undoped) to 1.99 Å. The deviation of the average Mn-O-Mn bond angle from the ideal undistorted value of 180° is less for the Na-doped compound, indicating a better symmetry after doping. Anti-ferromagnetic spin ordering resulting from Mn^{+3}-Mn^{+3} super-exchange is found in the undoped $NdMnO_3$ compound with Neel temperature 67.2K. But in the $Nd_{0.85}Na_{0.15}MnO_3$ compound, ferromagnetic spin ordering can be seen resulting from Mn^{+3}- O^{-2} - Mn^{+4} double exchange with a Curie temperature of 99.1K. Thus, Na doping introduces a significant change in low low-temperature magnetic ordering of the compound.

Keywords: Microstructure; Rietveld; Jahn-Teller Distortion; Double Exchange;

Morphology-Engineered Gallium Oxide Nanostructures with Enhanced Photocatalytic Performance via rGO Integration

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ABSTRACT

Gallium oxide (Ga_2O_3) nanostructures have emerged as promising photocatalysts due to their wide band gap, high chemical stability, and excellent charge transport characteristics. In this study, we investigate the enhanced photocatalytic performance of Ga_2O_3 nanostructures synthesized via a controlled chemical route. Morphological tuning through temperature modulation and the use of surface-directing agents resulted in distinct nanostructures and porous networks. Photocatalytic degradation of different organic pollutants under UV irradiation revealed that nanomaterials exhibited the highest activity, attributed to increased surface area and improved light-harvesting efficiency. The incorporation of reduced graphene oxide (rGO) further boosted performance by facilitating charge separation and suppressing electron-hole recombination, as confirmed by photoluminescence and electrochemical impedance spectroscopy analyses. The enhanced photocatalytic behaviour was also supported by reduced band gap energy and increased generation of reactive oxygen species. These findings highlight the crucial role of morphology and interfacial engineering in tailoring the photocatalytic efficiency of Ga_2O_3-based nanomaterials, offering potential applications in environmental remediation and solar energy conversion.

Keywords: Gallium oxide (Ga_2O_3) nanostructures; reduced graphene oxide (rGO); Photocatalytic degradation; organic pollutants

Facile Synthesis of Nickel Ferrite Hollow Microspheres for Proficient Electrochemical H_2O_2 Sensing Applications

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ABSTRACT

Hydrogen peroxide (H_2O_2), a key reactive oxygen species, is vital in environmental, clinical, and industrial applications, necessitating its accurate and rapid detection. This study reports the synthesis and application of hollow nickel ferrite ($NiFe_2O_4$) microspheres as a non-enzymatic electrochemical sensor for H_2O_2 detection. The microspheres were synthesized via a one-pot solvothermal method using nickel and ferric chloride precursors in ethylene glycol, with ammonium acetate as a stabilizer. Structural and morphological characterizations using Powder X-ray Diffraction (PXRD), Field Emission Scanning Electron Microscopy (FESEM), and Fourier-transform Infrared Spectroscopy (FTIR) confirmed a single-phase cubic spinel structure ($Fd\bar{3}m$), with a crystallite size of ~ 546 nm and uniform hollow morphology (~ 248 nm particle size). $NiFe_2O_4$-modified glassy carbon electrode (GCE) employed for H_2O_2 sensing in phosphate-buffered medium (PBS, pH 7.0), revealed excellent catalytic activity toward H_2O_2 reduction, with a fast response (~5 s), broad linear range (0.1–4.0 mM, $R^2 = 0.998$), low limit of detection (0.528 mM), and high sensitivity (6.337 μA/mM) superior to many other available electroactive materials. The electrocatalytic behavior is attributed to the dynamic redox activity at Ni^{2+}/Ni^{3+} and Fe^{3+}/Fe^{2+} sites, mimicking peroxidase-like activity. The sensor exhibited strong stability and selectivity, highlighting its promising real-world applications for non-enzymatic H_2O_2 detection in the field of biosensing and environmental monitoring purposes.

Keywords: Hydrogen peroxide sensing, Nickel ferrite ($NiFe_2O_4$), Electrochemical sensor, non-enzymatic detection.

Deactivation Pathway of Gas Molecules on Pristine Germanene Nanosheet: A Density Functional Theory Study

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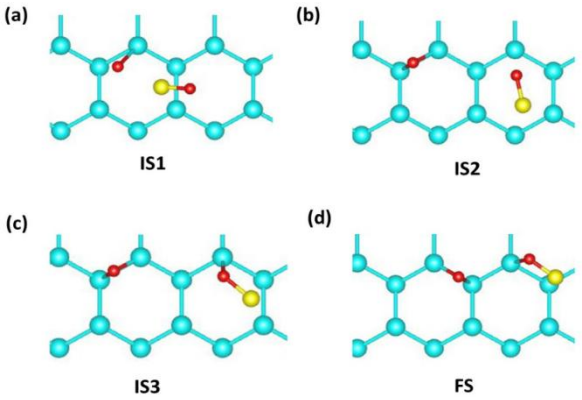
ABSTRACT

Using density functional theory (DFT), we investigated the adsorption behaviour of NO_2 and SO_2 gas molecules on Germanene nanosheets (GeNS). The analysis reveals that GeNS exhibits pronounced chemical reactivity toward these gases, with adsorption energies surpassing 1.00 eV. The thermal robustness of GeNS at elevated temperatures, along with a systematic evaluation of adsorption thermodynamics, underscores its stability under operating conditions. These results position GeNS as a promising candidate for metal-free catalytic applications. Furthermore, thoroughly examining the deactivation pathways of gas molecules on germanene nanosheets enhances our understanding of their surface chemistry and paves the way for new applications in catalysis and gas sensing technologies.



Top view of GeNS where the SO_2 molecule is adsorbed/inactivated. (a) intermediate state 1 (IS1), (b) intermediate state 2 (IS2), (c) intermediate state 3 (IS3), (d) Final state (FS).

Keywords: Density Functional Theory, Germanene Nano-sheet, Adsorption, NEB

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Eco-Friendly Solvothermal Synthesis of $Ni_{0.5}Co_{0.5}Fe_2O_4$Solid Microspheres as High-Performance Electrode Material for Supercapattery with Excellent Cyclic Stability and Coulombic Efficiency

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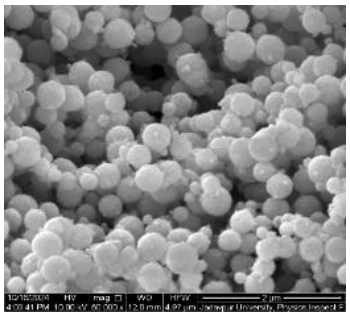
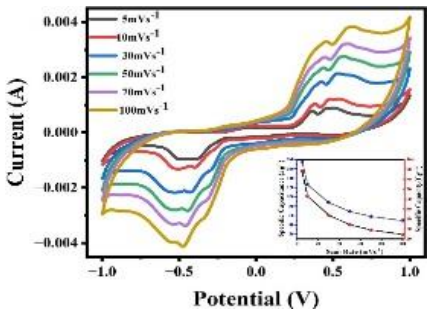
ABSTRACT

Supercapaterries integrate the effect of high-power density of supercapacitors with the high energy density of batteries, making them a promising candidate for advanced sustainable energy storage applications. [1-2]Three-dimensional, self-assembled mesoporous $Ni_{0.5}Co_{0.5}Fe_2O_4$ solid microspheres have been synthesized via a one-pot, template-free, cost-effective, and environmentally benign solvothermal method. The physicochemical properties of $Ni_{0.5}Co_{0.5}Fe_2O_4$ solid microspheres include a well-crystallized (~43.29 nm) cubic spinel ($Fd\bar{3}m$) structure and uniform microsphere morphology (~0.24 - 0.3 µm), assembled with ~17 nm nanoparticles, confirmed through PXRD, FESEM, HRTEM, and FTIR analyses. The BET surface area analysis reveals a specific surface area of 30.26 m^2g^{-1} with an average pore diameter of 2.79 nm, confirming the mesoporous nature of the sample. Cyclic voltammetry measurement in a conventional three-electrode configuration exhibits a high specific capacitance of 930 Fg^{-1}. For device fabrication, a slurry of $Ni_{0.5}Co_{0.5}Fe_2O_4$ microspheres, activated carbon, and PVDF (80:10:10 in NMP) coated onto a Cu foil as a current collector and a separator of Whatman paper soaked in 6 M KOH has been used. The symmetric device demonstrates superior performance, delivering the highest specific capacitance of 176.27 Fg^{-1}, an energy density of 17 $Whkg^{-1}$, a power density of 1.9 $kWkg^{-1}$, 140% capacitance retention, and 100% coulombic efficiency after 5000 cycles, indicating an efficient electrode material for supercapaterry energy storage device application.





Keywords: Supercapacitor; Supercapattery; Ferrite; Spinel.

Amla Fruit Extract-Mediated Biosynthesis and Characterisation of *m*-CuO Nanoparticles

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ABSTRACT

The present study examines the microstructural and optical properties of copper oxide nanoparticles (CuO-NPs) synthesized using Amla (*Phyllanthus emblica*) fruit extract. The powder XRD patterns of the CuO-NPs match the reference data from the ICDD card no. 01–089–5899, which confirms that the sample has a monoclinic structure with the space group C2/c (15). The microstructural parameters, including lattice constants (a, b, c, α, β, γ), unit cell volume (V), material density (ρ), and crystallite size (D), were determined to be a = 4.67 Å, b = 3.45 Å, c = 5.14 Å, β = 99.56°, $\alpha = \gamma$ = 90°, 81.66 Å^3, 6.47 g/cm^3, and 22.58 nm, respectively. The EDX spectrum confirms the elemental presence of Cu and O, with traces of Na and S impurities. TEM imaging reveals the spherical morphology of the CuO nanoparticles, with an average particle size of 47.62 nm. The optical band gap of the CuO NPs was determined using UV-Vis absorbance data converted to a Tauc plot, yielding a band gap value of 3.56 eV. These wide-band gap CuO NPs may have potential applications in photocatalysis and optoelectronics.

Keywords: Biosynthesis; Amla fruit extract; *m*-CuO; Nanomaterials.

Structural and Electrical Properties of Armchair Insb Nanotubes: A Density Functional Study

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ABSTRACT

One-dimensional nanomaterials like nanotubes and nanowires have the ability to lead to a technological revolution with their amazing and alluring properties. In fact, since Iijima's synthesis of carbon nanotubes in 1991, a significant amount of research has been accomplished in the field of 1-D nanomaterials. Group III-V composite semiconductor nanotubes, including BN, InAs, GaP, GaAs, and others, are attracting increasing attention lately due to their appealing properties. Another III-V prospective material, InSb, is used in a number of technologies, such as infrared detectors, sensors, lasers, solar cells, thin-film transistors, and LEDs. For assessing the efficacy of InSb nanotubes in modern nano-devices, the structural and electrical characteristics of several armchair InSb nanotubes are analysed using Density Functional Theory as executed in the SIESTA software. The band structure, density of states, binding energy, and other properties of armchair InSb nanotubes with diameters ranging from 13.47 Å to 25.69 Å are examined. This study illustrates that the stability of nanotubes grows with an increase in diameter. This study also shows that an increase in tube diameter leads to a decrease in band gap. It is demonstrated that by adjusting the tube diameter, the band gaps of armchair InSb nanotubes may be efficiently regulated over a range of 0.75 eV to 0.64 eV.

Keywords: Density Functional Theory; Binding Energy; Band gap.

Synthesis Strategies and Applications of Nanomaterials: Recent Progress and Future Prospects

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ABSTRACT

In the cutting-edge advancement of nanotechnology, nanomaterials (NMs) have become an indispensable cornerstone building block in technological breakthroughs due to their remarkable physical, chemical, and biological characteristics and superior performance over bulk counterparts. NMs are a class of materials with at least one dimension falling within the range of 1 to 100 nm. The properties of NMs can be precisely tuned by controlling the shape, size, and synthesis conditions. The materials' characteristics at the nanoscale regime significantly differ from bulk due to quantum confinement effects and a large surface area. According to the degree of spatial quantization, NMs with different nanostructures are generally categorised into 0D (nanoparticles, quantum dots), 1D (nanowires, nanobelts), 2D (thin films, nanosheets), and 3D (nanocubes, dendrimers). Many hazardous reducing agents are used in most of the NMs synthesis processes, which have a bad impact on the environment. In recent years, several research initiatives have been taken to produce nanoparticles using natural resources in lieu of hazardous chemicals in developing green technology. Several biological microorganisms, such as algae, bacteria, fungi, yeast, and extracts of plants, are extensively used to synthesize environment-friendly, productive, and cost-effective green NMs. The article highlighted an overview of NMs' classifications, synthesis strategies, and applications in several areas. Finally, future prospects and challenges related to NMs are also discussed.

Keywords: nanoparticles, green synthesis, microorganisms, applications

Molecular-Level Investigation of Nanoparticle Volume Fraction and Temperature Effects on Thermophysical Properties of Propylene Glycol-Based ZnO Nanofluid by Using EMD Simulation

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ABSTRACT

Molecular Dynamics (MD) simulation is a powerful tool for studying nanofluids at the atomic level, enabling analysis of fluid–nanoparticle interactions, thermal and concentration effects, and dynamic structural behavior beyond the reach of traditional experiments. The thermal conductivity and viscosity of Propylene glycol (PG) based ZnO nanofluid are calculated using Equilibrium Molecular Dynamics (EMD) simulations within the Green-Kubo framework, considering the effects of nanoparticle volume fraction (0.9 % - 3.5 %) and temperature (295 K- 325 K). The findings indicate that both thermal conductivity and viscosity of the nanofluid increase (Fig. 1a and Fig. 1b) with the volume fraction of ZnO. It is also observed that with temperature, thermal conductivity increases (Fig. 1a) while viscosity decreases (Fig. 1b). Addition of more nanoparticles improves the relative thermal conductivity by condensation of base fluid around the particles. This causes increased interactions between ZnO nanoparticles and PG, resulting in higher viscosity. The variation of mean-squared displacement (MSD) of PG in a nanofluid with a fixed volume fraction of 2.3% has been studied with simulation time for different temperatures to explore the underlying mechanisms responsible for the enhancement in thermal conductivity with temperature. The highest MSD is observed at 325 K, while the lowest is seen at 295 K. EMDs offer crucial molecular-level understanding of how ZnO nanoparticles influence the structural and dynamic behaviour of PG, directly impacting the nanofluids' thermal and rheological performances.

Keywords: Nanofluids; Equilibrium molecular dynamics simulation; Thermal Conductivity; Mean square displacement.

Modulation of the Electronic Structure of In-Situ Built Schottky Junction in a Two-Dimensional MXene Layer

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ABSTRACT

The modulation of electronic properties at metal-semiconductor interfaces is crucial for advancing nanoscale electronic devices. In this study, we investigate the electronic properties of in-situ built Schottky junctions in the Ti_3C_2 MXene layer. The partial oxidation of Ti_3C_2 MXene 2D layer leads to the formation of TiO_2 nanoparticles on the metallic MXene layer, resulting in multiple Schottky junction formation. The modulation of electronic properties of the in-situ built Schottky junctions was investigated through scanning probe microscopy (SPM). Scanning tunnelling microscopy (STM) and spectroscopy (STS) analysis reveal spatially resolved band edge variations across time-aged oxidized layers. Band mapping confirms the formation of a Schottky-type barrier at the MXene-TiO_2 interface. This is further supported by I-V measurements and nanoscale conductance mapping through conductive atomic force microscopy (CAFM), which highlight the asymmetric charge transport behavior of Schottky junctions. The ability to visualize and analyze the evaluation of interfacial electronic structure in the in-situ built Schottky junction provides valuable insight into the design of 2D heterojunction-based devices. Our findings establish that the Ti_3C_2 MXene-TiO_2 system has tunable properties for developing next-generation electronic, optoelectronic, and sensing applications.

Keywords: Ti_3C_2-MXene; TiO_2 nanoparticle; Scanning Probe Microscopy; Schottky junction.

Fabrication and Benefits of Functionally Graded Nitride Coatings via Magnetron Sputtering

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ABSTRACT

Functionally graded nitride coatings, produced through magnetron sputtering, offer a modern route to optimizing material properties across the thickness of thin films. This deposition method grants precise regulation of compositional and microstructural gradients by varying reactive gas ratios and adjusting key process parameters. Such control enables the development of nitride coatings featuring smooth transitions in mechanical strength, electrical performance, and resistance to wear or corrosion. Magnetron sputtering stands out due to its adaptability for large substrates, compatibility with low-temperature processes, and ability to form complex nitride architectures, including alloys and nanostructured layers. Compared to traditional coating techniques, it delivers higher throughput, strong film adhesion, and greater versatility for layering multicomponent systems. These graded nitride materials display marked improvements in durability, resistance to thermal cycling, and structural robustness, making them ideal for demanding applications in fields such as protective surfaces, optoelectronic elements, EM shielding, and medical devices. Ultimately, employing magnetron sputtering to introduce compositional gradients in nitride films opens new possibilities for designing coatings with superior multifunctional properties and extended operational lifetimes, highlighting clear advantages over conventional homogeneous layers.

Keywords: Sputtering, Magnetron, Coating, compatibility

Crystal Field Analysis on Eu^{3+} doped Phosphors Via Exchange Charge Model and Superposition Model

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ABSTRACT

A crystal field (CF) analysis on the energy levels of Eu^{3+} ions doped in various hosts has been performed to explore the effect of low symmetry on the crystal field. In many technologically significant phosphor materials, rare-earth (RE^{3+}) typically occupy low-symmetry sites, posing challenges for accurate determination of energy levels and modelling of crystal field parameters (CFPs). Particularly for ions like Eu^{3+}, the crystal field (CF) splitting, site symmetry, and nature of surrounding ligands significantly impact emission behaviour. To investigate the intrinsic low-symmetry behaviour and validate CFP modelling approaches, we consider host crystals where RE^{3+} ions occupy low-symmetry sites. Two independent models—the Exchange Charge Model (ECM) and the Superposition Model (SPM)—are employed using structural data from the hosts. The calculated energy spectra are successfully fitted with the experimentally obtained emission spectra of the Eu^{3+} doped phosphors. To compare the CFP sets obtained through two independent modelling approaches, we calculate the rotational invariants. The overall results show that our methodology may provide reliable information and useful guidance on the interpretation of spectroscopic data for rare earth metal ions in different host crystals.

Fabrication and Characterization of Green Synthesized CdSe Nano-ring based Dye Sensitized Solar Cell

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ABSTRACT

The research study represents the fabrication and characterization of CdSe nanoparticle-based dye-sensitized solar cell (DSSC). Because anthocyanin exhibits colours in the visible light range from red to blue, it is predicted to become a highly efficient sensitizer for a wide range of semiconductors [1-2]. The chemical reduction route was followed to synthesize CdSe nanocrystals using *Thevetia peruviana* leaf extract as a capping agent. For device fabrication, the as-prepared CdSe paste was applied to ITO and annealed for one hour at a temperature of 50 °C. Slides are then allowed to cool down to room temperature and are placed face down in a petri dish containing the *Thevetia peruviana* dye extracts for proper adsorption. To prepare the cathode slide, graphite paint was applied to the sensitive part of the ITO with a similar resistance, and an identical border was created as on the anode side. The fill factor (FF), efficiency (η), short-circuit current density (J_{sc}), and open-circuit voltage (V_{oc}) of the DSSCs were determined from Figure 1 and shown in Table 1.

(a) (b)

Fig. 1 (a) Current density (J) vs. Voltage (V) and (b) Power density (P) vs. Voltage (V)

Table 1. Photo-voltaic parameters of the as-prepared DSSC.

V_{max} (V)	J_{max} (mA/cm^2)	V_{oc} (V)	J_{sc} (mA/cm^2)	FF(%)	η(%)
0.460	3.206	0.662	4.273	52.1	1.473

Electronic And Thermoelectric Properties of Tifese

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ABSTRACT

The electronic and thermoelectric properties of Half-Heusler TiFeSe were studied within the framework of density functional theory (DFT) using the plane-wave basis set. The exchange-correlation interactions were treated using the generalised gradient approximation (GGA) with an on-site Hubbard *U* correction (*GGA+U*). The electronic energy band structure of the alloy was analysed along the high symmetry directions *Γ-X-K-Γ-L-W-X* of the Brillouin zone. The band structure revealed the semiconducting nature of the alloy, with an indirect band gap (1.23 eV) occurring between the *Γ* and *L* points. The thermoelectric properties of the alloy were explored in the temperature range of 100 K to 800 K. The positive value of the Seebeck coefficient (*S*) over the whole temperature zone indicates holes as the majority charge carriers. The computed value of the Seebeck coefficient at room temperature was found to be 182.54 μV/K. The nature of electrical conductivity suggests the degenerate semiconducting characteristics of the sample alloy. The alloy revealed the lowest lattice thermal conductivity of 0.06 W/m-K with a maximum figure of merit (*ZT*) value of 0.86 at 800 K.

Keywords: Heusler alloys; Energy bands; Seebeck coefficient; Figure of merit.

Polymer Composite-Based Triboelectric Nanogenerator for Sustainable Energy Harvesting Applications

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ABSTRACT

With the rising global emphasis on sustainable and renewable energy technologies, triboelectric nanogenerators (TENGs) have emerged as efficient platforms for harvesting ambient mechanical energy. This work presents the development of high-performance TENGs based on **polyvinylidene fluoride (PVDF)** polymer composites, tailored for green energy conversion. PVDF is chosen due to its strong electronegativity, high dielectric constant, and ferroelectric properties, which make it an ideal candidate for triboelectric applications. To enhance output performance, PVDF is reinforced with **5 wt% barium titanate ($BaTiO_3$)** nanoparticles, which improve charge trapping and interfacial polarization.

The fabricated PVDF–$BaTiO_3$ composite TENG achieves a remarkable **output voltage of 110 V**, a **short-circuit current of 32 µA**, and a **peak power density of 2.1 W/m²** under periodic vertical contact-separation motions at **5 Hz** and **20 N** force. Surface micro-patterning techniques are employed to enhance contact effectiveness, resulting in increased charge generation. The device exhibits excellent mechanical flexibility and maintains over **95% output stability after 10,000 cycles**, confirming its long-term durability.

The harvested energy is sufficient to **illuminate 40 LEDs** and **charge a 10 µF capacitor to 5 V within 40 seconds**. These results highlight the potential of PVDF-based composite TENGs in powering low-power electronics, wearable sensors, and self-sustaining systems, contributing to next-generation green energy solutions.

Keywords: Triboelectric Nanogenerator (TENG), PVDF Polymer Composite, Green Energy Harvesting, Dielectric Nanofillers

Aquatic Applications of Carbon Quantum Dots: Chemical Synthesis, Characterization and Growth Enhancement in Zebrafish

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ABSTRACT

Nanoparticles are tiny structures ranging from 1 to 100 nm in size, with one or more dimensions at the nanoscale, typically categorized into organic, inorganic, and carbon-based types, exhibiting superior properties compared to their larger counterparts. The quantum dots are nanomaterials ranging in size from less than 10nm. Fluorescent carbon nanoparticles, also known as carbon quantum dots, represent a novel class of nanomaterials with excellent photoluminescence properties, simple and cost-effective synthesis methods, inexpensive starting materials, water solubility, low toxicity, chemical stability, and ease of surface functionalization. Considering its biocompatible and less toxic nature, it has a wide application for in vivo studies and the biological field, preferably in aquaculture. The animal used in this study is the Zebrafish, considering its 70% homology to human beings. The carbon dots are synthesized chemically using L-Histidine as an amino acid precursor. The characterization includes Fluorescence microscopy, SEM, TEM, EDAX, PL, FTIR, UV Vis, and UV Transilluminator. The C-dots are incorporated into zebrafish feed, and the growth enhancement is assessed through biochemical, haematological, and enzymatic assays.

Keywords: Nanomaterials; Carbon quantum dots; Zebrafish, Biocompatible; Aquaculture.

Bio-medicinal Applications of Graphene Derivatives and its Composites

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ABSTRACT

Graphene, a single layer of sp^2-bonded carbon atoms arrayed into a honeycomb 2D carbonaceous nanomaterial, has attracted wide interest due to its extraordinary electrical, mechanical, and thermal properties. In addition to graphene, graphene derivatives such as graphene oxide (GO) and reduced GO (rGO) decorated by different atomic doping and their different composite have attracted much attention in various research fields such as sensing, nanoelectronics, energy-storage, catalysis, and nanobiotechnology.

Recently, metal decorated rGO/hybrid materials or nanocomposites have attracted intense research interest due to their Drug delivery, Cancer therapy, Biosensors, Bio-Imaging, and antibacterial activities. Graphene Oxide is mainly used in biomedicine, such as for drug delivery, cancer therapy, imaging, and biosensors, because of its physicochemical properties and biocompatibility with a large surface area. GO possesses a unique structure, i.e., the graphene basal plane is attached with various biocompatible functional groups like carboxylic (COOH) and hydroxyl (OH), etc.

Keywords: Graphene; Nanocomposite; Bio-imaging; Antibacterial.

Ionic-Responsive Graphene Oxide–Drug Hybrid Gel for Controlled Release of an Anticancer Drug

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ABSTRACT

A novel graphene oxide (GO)-based hydrogel has been developed for efficient drug delivery by integrating the anticancer agent doxorubicin (DOX) into a supramolecular gel matrix. This soft material was synthesized under ambient aqueous conditions, eliminating the need for harsh chemicals or elevated temperatures. The gelation process is driven by multiple non-covalent interactions, including hydrogen bonding, π–π stacking between aromatic rings of DOX and GO, and acid–base interactions, resulting in a robust three-dimensional network. Comprehensive characterization through transmission electron microscopy (TEM), atomic force microscopy (AFM), X-ray diffraction (XRD), and rheological analysis confirmed the structural uniformity and viscoelastic behaviour of the gel. Importantly, the addition of a small concentration of calcium ions (Ca^{2+}) significantly enhances the gel's drug-release performance by modulating the internal structure and diffusion dynamics. UV-visible spectroscopy was used to monitor the release of DOX, revealing a controlled and sustained release profile over time. This system highlights the potential of GO-based supramolecular gels as smart drug delivery platforms. Its biocompatible components, simple synthesis, and responsive behaviour to ionic triggers suggest wide applicability in localized cancer therapy and other biomedical applications requiring precise control over drug release.

Keywords: Graphene oxide; Supramolecular interactions; Gel; Controlled drug release

Development of CNT-Al_2O_3/PVDF nanocomposite based self powered Piezoelectric Mechanosensor for the Detection of Human Physiological Movement

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ABSTRACT

Piezoelectric polymer composites are increasingly receiving interest due to their applications in energy harvesting, tactile mechanosensing, bio-implants, and biomedical devices. The present study is concerned with the synthesis and characterization of CNT/Al_2O_3 incorporated poly (vinylidene fluoride) (PVDF) nanocomposite film (ACP) and the fabrication of a self-powered piezoelectric mechanosensor for recognition of different human physiological movements. The structural properties of the polymer nanocomposite have been investigated by using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) techniques, which confirm the enhancement of the electroactive β phase of the ACP nanocomposite film due to the incorporation of the CNT/Al_2O_3 nanoparticles in the PVDF matrix. The energy harvesting performance of the device has been investigated under different human body parts movements. The fabricated device harvests low-frequency biomechanical energy and produces ~20 V open circuit voltage under periodic, gentle human finger impaction. For the investigation of the application, a prototype monitoring glove was developed by integrating the self-powered mechanosensors (~1 × 3 cm^2) onto the fingers of a vinyl glove. Well-distinguished signal patterns due to the movements of the index, middle, and ring fingers are generated and recorded via the monitoring glove. Thus, the mechanosensors attached to the glove fingers are capable of recognizing the fine motions of the different fingers as well as precisely discriminating between their bending motions.

Keywords: CNT-Al_2O_3/PVDF Nanocomposite; β-Phase Enhancement; Piezoelectric Nanogenerator; Mechanosensor.

Fabrication Of ZnO Nanorod-Based Bio-Sensor and Its Application

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ABSTRACT

In this paper, we will report on the detailed procedure of fabrication of a biosensor utilizing Zinc oxide (ZnO) nanorod thin film with a large surface-to-volume ratio. The deposition was carried out by a two-step chemical process, where the seed layer was deposited by spin coating of the prepared sol under predetermined conditions on Cr/Au-coated glass substrate, and the nanorod thin film was grown by low low-temperature dip coating method. The optical characterization of the thin films was carried out by measuring optical transmission using an ultraviolet-visible-near infrared (UV-VIS-NIR) spectrophotometer and photoluminescence (PL). The microstructure of the thin films was characterized by X-ray diffraction (XRD) and scanning electron microscope (SEM).

The as-deposited ZnO nanorod thin film was utilized to fabricate a biosensor with interdigitated metal contacts. Anti-horseradish peroxide (anti-HRP) antibodies were detected using this biosensor. These biosensors, thus fabricated using this low-temperature, facile fabrication technique, exhibited excellent sensitivity and acceptable selectivity. This biosensor thus demonstrated provides an easy means of detection of trace amounts of antibodies.

Keyword: ZnO, thin film, nanorod, biosensor

Role Of Band Offset at Amorphous Crystalline Interface at Back Surface Field Layer in Silicon Hetero Junction Solar Cells With P-C-Si Wafer: A Simulation Study

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ABSTRACT

Amorphous /crystalline (a-Si: H/ c-Si) silicon heterojunction with intrinsic thin layer (HIT) cells offer a low-cost alternative to crystalline silicon solar cells. In this study, the detailed integrated electrical-optical model – Amorphous Semiconductor Device Modeling Program (ASDMP) – is used to analyze the performance of HIT solar cells based on P-type crystalline silicon (c-Si) wafers with different BSF layers having different mobility band gaps. In the first part of the simulation study, the influence of amorphous/crystalline valence band discontinuity is investigated. The modeling reveals that the valence band discontinuity (ΔE_v) at the c-Si/P^{++}-a-S: H BSF interface has a strong influence on cell performance when it is very large (ΔE_v>0.60 eV). In particular, large ΔE_v at the c-Si/P-BSF hinders hole collection at the back contact due to large hole accumulation at the c-Si/ a-Si: H interface and brings down the fill factor. The performance of a P-type double HIT cell with µc-Si: H BSF layer has been studied to predict a structure capable of yielding high V_{oc} as well as high FF. Modeling indicates that I-µc-Si: H /P^+-µc-Si: H (with mobility gap ~1.4 eV) as the BSF design on the rear face of the P-type c-Si wafer can increase the efficiency by ~2.12% relative to a double HIT cell with conventional P^+-a-Si: H BSF and by ~0.74% relative to a front HIT cell on a P-type wafer.

Keywords: HIT solar cells; band offset; back surface field layer; micro-crystalline silicon

Investigating the Effect of M-Site Atom Substitution on the Structural Properties of Frustrated Quantum Materials $Dy_2Fe_xGa_{(1-X)}SbO_7$ (X=0.2,0.5,0.8) Pyrochlore

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ABSTRACT

Rare-earth pyrochlore oxides, $R_2M_2O_7$ (where M are transition or non-transition metals) have gained research interest recently from both theoretical and experimental points of view for application fields, for example, solid-oxide fuel cells, oxygen sensors, thermistors, resistors and switches, radioactive disposal matrix, solar energy conservation, adiabatic demagnetization refrigerator, *etc*. Different degrees of disorder and frustration can be achieved by the appropriate choice of metals at R and M sites of the pyrochlore solid solution. The M-site atom plays a crucial role in determining the material's behaviour. To investigate the effect of substituting different M-site atoms on the structural properties of $Dy_2Fe_xGa_{(1-x)}SbO_7$ $(x=0.2,0.5,0.8)$, pyrochlore oxides are synthesized from a mixture of analytical grade Dy_2O_3, Fe_2O_3, Ga_2O_3, and Sb_2O_5 in the molar ratio, which was heated in air at 1200^0C. Before each heat treatment, the powder mixture was ground in a mortar for about 10 hours. The compounds are structurally characterised by powder X-ray diffraction using the Cu-$K\alpha$ radiation within the range of $10° < 2\theta < 90°$. The FULLPROF code is used to refine the crystal structure by the Rietveld method. From the X-ray diffraction peak, the lattice constant (a_0), 48f oxygen positional x parameter increases, and the positions of the (222) peak decrease with increasing Fe concentration.

Keywords: Rare-earth, Pyrochlore, Frustration.

Development Of New Nuclear Radiation Shielding Materials Made of Glass Doped with High Atomic Number Elements

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ABSTRACT

With the increasing use of radiation sources in medical fields and nuclear reactors, the development of effective radiation shielding material is highly important. To attenuate the radiation coming from the radiation sources, materials with high atomic number, such as Lead, are commonly used [1,2]. But due to its heaviness and environmental toxicity, there is a need for an alternative material that can provide effective radiation shielding without the adverse effects associated with Lead. Glass doped with high atomic number elements such as Bismath, Tungsten, etc. could be the best alternative because it is transparent, thermally stable and poses no harm to the environment. To fabricate such an effective radiation shielding glass, we first took the help of X-COM and GEANT-4 simulation software and computed the radiation shielding parameters, such as mass attenuation coefficient, half value layer, etc., by giving the primary input data, such as mole fraction and densities of the samples. Then glass samples with the compound (88-x) B_2O_3 + xBi_2O_3 + 6$AgNO_3$+6CdO (where x =5,10,15,20, and 25 mol%) have been prepared at Barasat Government College using the melt quenching technique, and their radiation parameters are determined using BaF_2 scintillation detectors [3] and γ-radiation sources at Variable Energy Cyclotron Centre, Kolkata. It is observed that the experimental results are in good agreement with the simulation results.

Keywords: Mass attenuation coefficient, Bismath Borate Glass, Radiation Shielding

Spinel $MnCoFeO_4$ Nanostructures: A Trimetallic Route to High-Performance Pseudocapacitive Energy Storage

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ABSTRACT

The demand for clean and sustainable energy storage devices has accelerated the search for advanced electrode materials with high conductivity, rich redox activity, and structural stability for high-performance supercapacitors. In this context, $MnCoFeO_4$ spinel ferrite was synthesized via a co-precipitation method followed by calcination and investigated as a cathode material for supercapacitors using a three-electrode system in 3 M KOH electrolyte. Structural analysis through X-ray diffraction (XRD) confirmed the formation of a single-phase cubic spinel structure. Scanning electron microscopy (SEM) revealed nanoparticle morphology with an average particle size of 25.84 nm, promoting high surface area, efficient ion diffusion, and improved electrochemical interaction. Fourier-transform infrared (FTIR) spectroscopy indicated the presence of characteristic metal–oxygen stretching bands, validating the successful formation of the ferrite framework.

Electrochemical characterization was conducted through cyclic voltammetry (CV), galvanostatic charge–discharge (GCD), and electrochemical impedance spectroscopy (EIS). The $MnCoFeO_4$ electrode exhibited prominent redox peaks in CV, consistent with pseudocapacitive behaviour, and delivered a specific capacitance of 663 F/g at a 2 mV/s scan rate. GCD analysis further demonstrated a high specific capacitance of 765.3 F/g at a current density of 1.5 A/g. EIS revealed a low charge-transfer resistance, underscoring favourable charge transport kinetics. The synergistic effect of Mn, Co, and Fe ions within the spinel structure enhances redox activity and electrochemical reversibility. These findings establish $MnCoFeO_4$ as a promising and efficient cathode material for next-generation supercapacitor applications.

Keywords: $MnCoFeO_4$; Spinel ferrite; Energy storage; Supercapacitor.

Improved Dielectric Properties and Enhanced Photocatalytic Activity of Fe-doped ZnO@rGO Nanocomposite on Degradation of Organic Aqueous Pollutant

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ABSTRACT

Designing stable, highly efficient metal-oxide photocatalysts for the degradation of organic pollutants is a subject of intense research. In this work, Fe-doped ZnO (specifically $Zn_{0.85}Fe_{0.15}O$**)**, and its nanocomposites with reduced graphene oxide (rGO) having different volume fractions v ($0 \leq v \leq 27$ %) were synthesized via a co-precipitation method. The materials were characterized by XRD**,** FT-IR**,** UV–Vis spectroscopy**,** and FESEM. Notably, the composite containing 19.7 vol% of rGO, named as 20GZFO, exhibited the smallest particle size (~77 nm), implying the largest surface area and the narrowest optical band gap (2.9 eV) among the series of nanocomposites studied. The photocatalytic activity of these composites was investigated by the degradation of methylene blue dye under visible light irradiation. The activity was found to depend on the percentage of volume fraction (v) of rGO in the composite. The nanocomposite having 19.7% volume fraction of rGO demonstrated outstanding photocatalytic performance, achieving a degradation efficiency of 97.56%. The enhanced photocatalytic activity may be attributed to the prolonged lifetime of a large number of electron–hole pairs produced in 20GZFO due to the heterogeneous junction. During the Photocatalytic reaction Photocatalyst's stability and reusability ensure practical application success. With increasing rGO content, the dielectric constant of $Zn_{0.85}Fe0_{.15}O$ composites improved significantly. The highest electrical conductivity was observed in $Zn_{0.85}Fe_{0.15}O$@rGO composite having 23.5% volume fraction of rGO, as estimated using Jonscher's power law. This particular which is nanocomposite exhibits a huge dielectric constant, approximately 4 times that of pure $Zn_{0.85}Fe_{0.15}O$, along with moderate dielectric loss, making it a potential candidate for a charge storage device.

Boosting the Energy Harvesting Performance of a Piezoelectric Nanogenerator Using a Multiferroic Composite

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ABSTRACT

The quest for sustainable and efficient energy alternatives has driven significant research into harvesting ambient mechanical energy for powering portable, self-sufficient electronic systems. One promising strategy involves converting mechanical energy—originating from human movement, ambient vibrations, and acoustic signals—into electrical output through piezoelectric mechanisms. Among various materials, polyvinylidene difluoride (PVDF) emerges exceptional piezoelectric polymer due to its structural flexibility, low cost, and ease of processing. Although PVDF predominantly exhibits a non-polar α-phase (TGTG conformation), the electroactive β-phase (TTTT conformation) is required for efficient energy conversion. This β-phase can be induced and enhanced by incorporating suitable nanofillers. This study utilizes bismuth ferrite ($BiFeO_3$), a multiferroic perovskite, as a functional nanofiller that enhances the electroactive properties of PVDF. Films of $BiFeO_3$@PVDF were synthesized using sol-gel derived $BiFeO_3$ (BFO) with different weight fractions (3%, 5%, 7% and 10%). This nanocomposite enhances the β-phase in PVDF and significantly improves the polarization properties and hence energy harvesting capabilities. Structural analysis using XRD and FTIR confirms the enhancement of β-phase content in $BiFeO_3$@PVDF composite and is found to be maximum (~94%) for a 7 wt% BFO-containing composite named as BFO_7. The piezoelectric nanogenerator based on BFO_7 is observed to generate 24 V open circuit voltage, 4 nA short circuit current, and 14.4 $\mu W/cm^2$ power under constant and periodic hammering with a swing machine. Demonstrating high sensitivity to common mechanical stimuli such as heel pressing, mouse clicking, and drum toy tapping, the PVDF-BFO nanogenerator is also capable of powering LEDs through rectification, highlighting its potential for self-powered microelectronic applications.

Keywords: Multiferroic, Piezoelectric, Nanogenerator.

Green Synthesis of Ferromagnetic α-Fe_2O_3 Nanoparticles in the presence of *Nyctanthes arbor-tristis* L. Leaves Extract for Methyl Orange Removal in Wastewater Remediation

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ABSTRACT

In this work, iron oxide nanoparticles (NPs) were eco-friendly synthesized using $FeCl_3$ as the precursor in the presence of *Nyctanthes arbor-tristis* L. leaf extract. Based on electron microscopic observations, the nanoparticles exhibited sizes ranging from 18 nm to 66 nm. The crystallographic interplanar spacing (d_{hkl}) was calculated from high-resolution TEM (HRTEM) images. Rietveld refinement confirmed pure α-Fe_2O_3 phase with rhombohedral $R\bar{3}c$ (167) symmetry and lattice constants a = b = 0.49 nm, c = 1.35 nm. Crystallographic analysis revealed an average crystallite size of 40.31 nm in the synthesized sample. Two-dimensional and three-dimensional electron density (ED) maps offer comprehensive insights into the spatial distribution of ions. UV-Vis spectroscopic analysis was employed to estimate the direct and indirect optical band gap (E_g) 2.43 eV and 1.87 eV, respectively. Magnetic characterization indicated that the synthesized α-Fe_2O_3 nanoparticles exhibit canted ferromagnetism, with a room temperature coercivity of 129.87×10^{-4} T and a Morin transition temperature of 201 K. Photocatalytic studies were carried out on the synthesized canted ferromagnetic α-Fe_2O_3 nanoparticles for the degradation of methyl orange (MO). A significant enhancement in MO degradation was observed with the addition of a small quantity of H_2O_2, highlighting its applicability in the field of wastewater purification.

Structural, Spectroscopic and Electronic Properties of Mn^{4+} Doped Y_2GaSbO_7 Phosphor for Applications in Optoelectronics

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ABSTRACT

We have investigated structural, spectroscopic, and electronic properties of Mn^{4+} ions doped into Y_2GaSbO_7 crystals (YGSO: xMn^{4+}; x = 0–0.2). The stable pyrochlore phase shows the lattice shrinkage, which increases with Mn^{4+} concentration, thus increasing the crystal field strength. XPS confirms the predominant Mn^{4+} state with partial reduction to Mn^{3+}, consistent with bond valence sum (BVS) results. UV-Vis spectroscopy demonstrates a reduction in the energy gap between Ga/Sb-3d and O-2p states with increasing Mn^{4+} concentrations. The band gap tunability makes YGSO: xMn^{4+} suitable for visible-light photocatalytic and optoelectronic applications. DFT calculations show that Mn^{4+} doping introduces new electronic states near the Fermi level, reducing the band gap and influencing optical properties. The optimized crystal structure exhibits minimal triclinic distortion. PL spectra reveal deep-red emission (630–680 nm), with emission intensity peaking at x = 0.1. The spectra provide insights into Mn^{4+}–O^{2-} bond hybridization and crystal field effects, and exhibit promising evidence for phosphor-converted white LED and clinical phototherapy applications. Mn^{4+} substitution at the B-site lowers symmetry from trigonal (D_{3d}) to triclinic (C_1), increasing the CF strength and energy level splitting. The trigonal SPM/CFPs yield the computed CF energy levels, which align well with those determined from the PL spectra.

Plasmonic Nanohybrid Contrast Agent for Enhanced Near-Infrared Bioimaging

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ABSTRACT

Near-infrared (NIR) emissive and water-dispersible nanostructures are gaining prominence as non-invasive tools for deep-tissue imaging and disease diagnostics. We report a novel hybrid nanoplatform comprising gold nanorods (AuNRs) encapsulated in a mesoporous silica shell (AuNRs@$mSiO_2$), with tunable thickness (7–25 nm), designed to efficiently load the FDA-approved NIR dye indocyanine green (ICG). To further enhance aqueous stability and biocompatibility, the dye-loaded system was functionalized with either polyacrylic acid (PAA) or graphene oxide (GO), forming AuNRs@$mSiO_2$-ICG@PAA/GO nanohybrids. Structural and optical analyses confirmed the formation of stable, monodisperse constructs exhibiting amplified excitonic absorption and fluorescence emission from ICG. Notably, the plasmonic AuNR core synergistically enhanced two-photon excitation fluorescence (TPEF), enabling deeper tissue penetration and stronger imaging signals. This dual enhancement—via NIR fluorescence stabilization and plasmon-coupled TPEF—addresses major limitations of free ICG, such as rapid photobleaching and poor solubility. The developed nanohybrids show significant promise as next-generation NIR contrast agents for image-guided cancer diagnostics and therapeutic monitoring.

Keywords: localised surface plasmon resonance; AuNRs, cancer cell, bioimaging.

Polymorphism and Physical Properties of Antiperovskites

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ABSTRACT

In the last few decades, intermetallic perovskite compounds represented by RET_3M (*RE* = Rare earth or Y, Sc, 5*f* metals; T = transition metals and M = light metalloids) have drawn cumulative scientific attention due to their intriguing character. Particular attention is being paid to rare earth and transition metal-based compounds, $RET_3B_xC_{1-x}$ (*RE* = Rare earth metal; T = Transition metal) series. In this series, the $REPd_3B$ compounds crystallize in a cubic perovskite structure with *Pm-3m* space group symmetry. The parent binary $REPd_3$ also forms a stable phase with the $AuCu_3$ type crystal structure. Although the ideal perovskite compounds form in a cubic structure, many of them actually form in a distorted structure in a lower symmetry. The distorted structures at room temperature often get transformed to the cubic structure at high temperature, pressure, or by annealing at high temperature. One of such distorted structures in lower symmetry can be observed in the $REPt_3B$ series of compounds, which has a tetragonal crystal structure with space group *P4mm*. It should be noted here that the parent binary $REPt_3$ does not form in the $AuCu_3$ type crystal structure (instead, it forms in the cubic $AuBe_5$-type structure). An extensive study on these ternary perovskite compounds and their binary analogues can enhance understanding of the intriguing chemical and physical properties governing the relationship between the structural stability and chemical bonding mechanisms in these phases.

Keywords: Perovskite; $REPt_3B$; Crystal structure;

Structural and Magnetic Properties of Co-Doped $Cafe_2o_4$ Nanoparticles Prepared by the Sol-Gel Route

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ABSTRACT

Structural and magnetic properties of cobalt-doped calcium ferrite nanoparticles with an average crystallite size of ~35 nm have been synthesized by the sol-gel method by mixing calcium nitrate, ferric nitrate and cobalt acetate in a stoichiometric ratio in the presence of ethylene glycol. As-synthesised nanoparticles were annealed at different temperatures, and their structural and magnetic properties were evaluated. The FESEM images show that the average particle size was found to be ~180 nm. X-ray diffraction studies showed that, unlike most ferrites, as-synthesized $Ca_{0.9}Co_{0.1}Fe_2O_4$ showed a slow transformation to orthorhombic structure when annealed above 400 °C. Single phase orthorhombic $Ca_{0.9}Co_{0.1}Fe_2O_4$ was obtained upon annealing at 1100 °C. Thermo-gravimetric analysis shows that the first mass loss is observed in the region between room temperature and ~170 °C corresponding to the removal of water and absorbed gases. The final mass loss between 450 °C and 700 °C indicates the crystallisation of the orthorhombic phase of $Ca_{0.9}Co_{0.1}Fe_2O_4$. Magnetization data show that in the case of as-synthesised $Ca_{0.9}Co_{0.1}Fe_2O_4$ nanoparticles, superparamagnetic behaviour with nearly zero remanent magnetization (M_r) and zero coercivity (H_c) at room temperature was observed. But with the substitution of mere 0.1 mole% Co in the Ca site of $CaFe_2O_4$, superparamagnetic behaviour is lost and ferromagnetic behaviour sets in, as can be noticed by the large H_c and M_r of the sample.

Keywords: orthorhombic, superparamagnetic

Bimetallic Oxide–Boron-Doped Biochar Hybrid Electrocatalyst for Efficient Degradation of Cationic and Anionic Dyes in Wastewater

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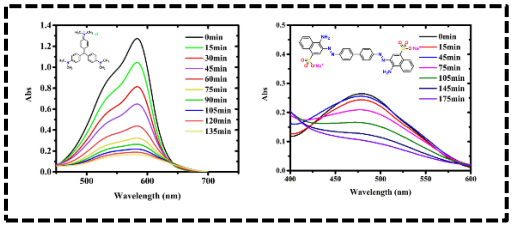
ABSTRACT

Water pollution from industrial dye effluents poses a serious environmental and public health threat due to the toxicity, stability, and persistence of synthetic dyes in aquatic systems. Conventional treatment methods often fall short in achieving complete degradation, especially for complex dye molecules. This study presents a novel hybrid electrocatalyst comprising bimetallic oxides integrated with boron-doped biochar (B-BC), designed for the electrocatalytic degradation of both cationic (Crystal Violet) and anionic dyes (Congo Red). A multi-step procedure, including hydrothermal synthesis and in-situ composite creation, was used to create the hybrid material. Comprehensive physicochemical characterization using XRD, SEM, FTIR, and Raman spectroscopy confirmed the structural integrity, morphology, and functional groups of the catalyst. Electrochemical degradation experiments demonstrated high efficiency and selectivity toward both dye classes under controlled conditions. Notably, the catalyst achieved 95% removal of Crystal Violet and 80% removal of Congo Red at a current density of 90 mA/cm². The superior performance is attributed to the synergistic interaction between the bimetallic oxide phases and the B-BC matrix, which enhances charge transfer, active site accessibility, and reactive oxygen species (ROS) generation. These findings highlight the promise of multifunctional hybrid materials for sustainable wastewater treatment and provide a foundation for the future design of advanced electrocatalysts for environmental remediation.



Keywords: Electrocatalytic degradation; Biochar; Hydrothermal; ROS.

Growth and Properties of Green Synthesized ZnO Nanostructures using *Moringa oleifera* and its Antimicrobial Activity Against *S. aureus*

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ABSTRACT

A simple wet-chemical method has been used to synthesized ZnO nanoparticles using *Moringa oleifera* (drumstick) leaves extract. Nanoparticles of size ~ 5 nm are found to form. XRD study revealed the well-crystalline nanostructure with a hexagonal unit cell structure. The material has low absorbance in the UV region. Band gap enhancement was observed due to quantum confinement in the nanostructures. The synthesized ZnO exhibits excellent photoluminescence in the UV region due to band edge transition. The green-synthesised ZnO nanoparticles show antimicrobial activity against *S. aureus*.

Keywords: Green-synthesis; Nanoparticle; Optical-property; Quantum-confinement

Investigation of Electrical Conductivity and Dielectric Behaviour of Non-Stoichiometric Nanocrystalline Nickel Ferrite

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ABSTRACT

This study delves into the electrical transport parameters of chemically synthesized nanocrystalline nonstoichiometric nickel ferrite that has been prepared by high-energy ball milling. The samples' dc conductivity exhibits semiconducting characteristics. The Schnakenberg acoustical one-phonon aided hopping model is appropriate at lower temperatures, whereas the adiabatic tiny polaron model is best suited for assessing the dc conductivity at higher temperatures. A maximum has been seen in the temperature behavior of s, and the frequency-dependent conductivity has been represented by the power equation $\sigma'(f) \propto f^s$. The electric modulus vector has been used to explain the samples' dielectric characteristics. Different samples' dc and ac activation energies have been measured. The capacitance-voltage characteristics have been used to obtain the diode parameters from the Schottky diode created by the metallic electrode and semiconductor junction. Furthermore, ongoing studies may explore the integration of non-stoichiometric nickel ferrite into composite materials, potentially unlocking new functionalities and improving overall device efficiency. This research could pave the way for innovative solutions in renewable energy technologies and smart electronic applications.

Keywords: Ball Mill, Ferrite, Polaron, Schottky Diode.

Structural, Electronic, Energetic and Mechanical Properties of Inorganic Nanotubes using DFTB Method

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ABSTRACT

The helical structure of nanotubes, with their semiconducting behavior and optical activity, opens up possible applications in nonlinear optics and solar-cell technology. In our work, we have employed the parametrized density functional tight-binding (DFTB) method of Porezag et al., which has been described in detail elsewhere.

We present results of our theoretical calculations on the structural, energetic, and mechanical properties of different inorganic nanotubes, like ZnSe nanotubes, ZnS nanotubes, and GaAs nanotubes. We have calculated the strain energy, buckling, band gap, and Young modulus for both zigzag and armchair nanotubes and have studied their variation with tube radius. We have also studied the effect of flattening on the band gap values for both zigzag and armchair nanotubes. Our study predicts that the flattening may cause a possible semiconductor-to-metal transition in ZnSe nanotubes. The strain energies of GaAs nanotubes are comparable to those of other inorganic nanotubes and are insensitive to the tube helicity. The band gap of both armchair and zigzag tubes decreases with increasing tube radius. A certain degree of buckling is present in ZnSe nanotubes. We have also studied the mechanical properties of single-wall ZnSe nanotubes. We see that the Young modulus of single-wall ZnSe nanotubes is slightly higher than that of carbon nanotubes and depends on the tube radius and also on the chirality of the tube. The other interesting and characteristic observation of ZnS nanotube is that for the zigzag tube, the band gap decreases with increasing radius, and it passes through a broad maximum for armchair nanotubes.

Coexisting Dimorphic Cubic Phases and Complex Magnetism in the Binary $PrIr_3$ compound

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ABSTRACT

The binary compound $PrIr_3$ was prepared as a polycrystalline sample through the arc melting method. Analysis of the powder X-ray diffraction patterns indicates that the material exists as two coexisting cubic polymorphs, structurally similar to the $AuBe_5$ and $AuCu_3$ types. Specific heat under zero field and DC magnetic measurements reveal that the phase with $AuBe_5$-like symmetry shows ferromagnetic behavior below 12 K, whereas the $AuCu_3$-structured component remains non-magnetic down to 2.5 K. Measurements of magnetic relaxation, frequency-dependent susceptibility, and memory effects support the presence of glassy magnetism, likely originating at the interfaces between ferromagnetic and paramagnetic zones. This leads to a spin-glass transition temperature (T_{Sg} ~ 12 K) nearly identical to the Curie point (T_C ~ 12 K). A detailed evaluation near the second-order phase transition determines the transition temperature precisely and identifies the magnetic universality class corresponding to the $AuBe_5$-type structure. Additionally, magnetocaloric properties assessed via both heat capacity and magnetic data produce matching critical exponents α, β, and γ, though derived through independent approaches.

Keywords: Polymorphism, Ferromagnetic, Magnetocaloric, Universality class.

Mathematical Sciences and Statistics

Thermodynamical study of Modified Bekenstein-Hawking System in Fractal Universe

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ABSTRACT

In recent past, Hawking temperature has been generalized and Bekenstein entropy has been modified for the validity of the thermodynamical laws at the horizons (other than apparent horizon) of the FRW (Friedmann-Robertson-Walker) model of the Universe. Also, it has been shown that Bekenstein entropy gets correction in the modified gravity theories for any horizon. This leads to the idea of Modified Bekenstein-Hawking system where either entropy or temperature (or both) are modified or corrected for the validity of thermodynamical laws. The present work deals with a thermodynamical study in a FRW fractal universe filled with a perfect fluid having constant equation of state in four possible Modified Bekenstein-Hawking systems at the event horizon. The validity of the Generalized second law of thermodynamics (GSLT) and Thermodynamical equilibrium (TE) have been examined in such systems. It is found that Modified Bekenstein-Hawking system is more realistic on the event horizon in the fractal universe.

Keywords: Fractal Universe; Bekenstein entropy; Hawking temperature; Non-equilibrium Thermodynamics.

Open Economy Macroeconomics and Environmental Capital

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ABSTRACT

This paper explores the macroeconomic implications of environmental capital and asset prices within an open economy framework. Although environmental considerations have gained prominence in macroeconomic discourse, theoretical literature remains limited in addressing the interplay between asset prices, capital stock dynamics, and environmental sustainability. To address this gap, the study develops a two-sector small open economy model to examine how interactions between macroeconomic policies and environmental factors influence the evolution of capital stock and asset prices, ultimately shaping sectoral output composition and employment. The model employs a standard dynamic adjustment process under perfect foresight, with a focus on transitional dynamics and the saddle-path stability of the system. The findings underscore the importance of differential adjustment speeds across capital stock, asset prices, and commodity prices, as well as the complex cross-sectoral effects generated by these changes.

Keywords: Environmental capital; Asset prices; Capital stock dynamics; Saddle path.

Can Chemical Reactions Tune Marangoni Forces to Steer Droplets?

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ABSTRACT

Droplet migration in microfluidic environments is strongly influenced by interfacial phenomena, particularly when surfactants and chemical reactions are involved. Inspired by biological systems that exploit such mechanisms for locomotion, we investigate the solutocapillary migration of a surfactant-laden droplet undergoing a first-order interfacial chemical reaction. The droplet is suspended in an external Poiseuille flow under an imposed chemical concentration gradient, leading to Marangoni stresses that drive its motion. Our model captures the coupled effects of solutal and surfactant-induced Marangoni forces, with the latter modified by surface reactions that dynamically alter surfactant concentration.

By applying asymptotic regular perturbation techniques at small surface Péclet numbers, we analytically solve the governing Stokes flow and transport equations. We demonstrate that surface reactions significantly affect the droplet's trajectory: streamwise migration is enhanced at first order in Péclet number, while cross-stream migration appears at second order. The interplay between reaction kinetics (quantified via the Damkohler number) and Marangoni numbers reveals critical thresholds where migration direction reverses. These thresholds shift with increased reaction rates, enabling potential control strategies for directed droplet transport. Our results provide valuable insights into how interfacial chemistry can be harnessed to steer droplets, with promising applications in biomedical delivery systems and active matter control. The theoretical benchmarks developed herein offer a foundation for future computational and experimental exploration.

Keywords: Solutocapillarity; Chemical Reactions; Stokes Flow.

Some Growth Properties of Composite Entire Functions Relating to (α,β,γ)-Order

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ABSTRACT

Let $f=\sum a_n z^n$ be an entire function defined on the finite complex plane $\mathbb{C}$. The maximum modulus function $M_f(r)$ of f on $|z|=r$ is defined as $M_f=\max|f(z)|$. Now let L be a class of continuous non-negative on $(-\infty,+\infty)$ functions α such that $\alpha(x)=\alpha(x_0)\geq 0$ for $x\leq x_0$ with $\alpha(x)\uparrow+\infty$ as $x_0\leq x\to+\infty$. We say that $\alpha\in L_1$, if $\alpha\in L$ and $\alpha(a+b)\leq\alpha(a)+\alpha(b)+c$ for all $a,b\geq R_0$ and fixed $c\in(0,+\infty)$. Further we say that $\alpha\in L_2$, if $\alpha\in L$ and $\alpha(x+O(1))=(1+o(1))\alpha(x)$ as $x\to+\infty$. Finally, $\alpha\in L_3$, if $\alpha\in L$ and $\alpha(a+b)\leq\alpha(a)+\alpha(b)$ for all $a,b\geq R_0$, i.e., α is subadditive. Clearly $L_3\subset L_1$. As a non-decreasing, subadditive and unbounded function, $\alpha(r)$ satisfies $\alpha(r)\leq\alpha(r+R_0)\leq\alpha(r)+\alpha(R_0)$ for any $R_0\geq 0$. This yields that $\alpha(r)\sim\alpha(r+R_0)$ as $r\to+\infty$. Throughout the present paper we take $\alpha,\alpha_1,\alpha_2,\alpha_3\in L_1$, $\beta\in L_2$, $\gamma\in L_3$.

Considering this Belaïdi et al. [B. Belaïdi and T. Biswas, Study of complex oscillation of solutions of a second order linear differential equation with entire coefficients of (α,β,γ)-order, WSEAS Trans. Math., 21 (2022), 361-370, doi: 10.37394/23206.2022.21.43.] have introduced the definitions of (α,β,γ)-order $\rho_{\alpha,\beta,\gamma)}[f]$ and (α,β,γ)-lower order.

$$\rho_{\alpha,\beta,\gamma)}[f]=\limsup_{r\to\infty}\frac{\alpha(\log^{[2]}(M(r,f)))}{\beta(\log(\gamma(r)))}\ \text{and}\ \lambda_{\alpha,\beta,\gamma)}[f]=\liminf_{r\to\infty}\frac{\alpha(\log^{[2]}(M(r,f)))}{\beta(\log(\gamma(r)))}.$$

In this paper, we discuss some growth properties of composite entire functions on the basis of their (α,β,γ)-order and (α,β,γ)-lower order.

Keywords: Entire function; growth; (α,β,γ)-order; (α,β,γ)-lower order.

Partial Tipping in Bistable Ecological Systems Under Periodic Environmental Variability

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ABSTRACT

Periodic environmental variability is a common terrestrial phenomenon affecting ecosystems and regulating their dynamics. Almost all earthly systems, including climate and ecological systems, are influenced by environmental periodicity. We intend to explore how sudden and dramatic changes in ecological systems occur due to periodically varying parameters. We demonstrate with numerical simulations that a periodic variation in species growth rate may cause switching between two coexisting attractors without crossing any bifurcation point. Such a switchover occurs only for specific initial population densities close to the basin boundary, leading to partial tipping if the frozen system is non-chaotic. The accumulation of those initial points depends on the frequency of forcing. Also, the probability of this critical transition shows some selective frequency response. Partial tipping may also occur for some initial points far from the basin boundary if the frozen system is chaotic. The surprise arrival of the trajectory from the initial point located almost at the basin's centre may be attributed to the unpredictability of the chaotic system. This phenomenon differs from traditional bifurcation tipping, rate tipping, and noise-induced tipping. The findings suggest that abrupt changes in population density may occur due to time-dependent variations in species growth parameters. Depending on the selective frequency of the periodic environmental variation, this may lead to species extinction or help the species to survive.

Keywords: Partial tipping; Periodic variation; Multistability; Tipping probability.

Almost Ricci Yamabe Soliton and Gradient Almost Ricci Yamabe Soliton on Hyperbolic Kenmotsu Manifolds

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ABSTRACT

This paper studies almost Ricci–Yamabe solitons and gradient almost Ricci–Yamabe solitons on 3-dimensional hyperbolic Kenmotsu manifolds. We examine the existence of such solitons when the soliton vector field or the gradient of the potential function coincides with the Reeb vector field. Relations among the scalar curvature and soliton functions are derived in both cases. Several corollaries are obtained to highlight the geometric implications of the results. An illustrative example is provided to verify the main findings.

Keywords: Almost Ricci–Yamabe soliton; gradient soliton; hyperbolic Kenmotsu manifold.

An Analysis of Road Accident in India by Dynamic Mathematical Model and Road Safety Measures

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ABSTRACT

Protecting human life from any kind of accident that claims hundreds of human lives is a global challenge. Therefore, this study attempts to understand the factors and parameters contributing to fatal road accidents in India and to develop a dynamic mathematical model in the form of simultaneous ordinary differential equations (ODEs). The proposed model is validated through numerical simulations and also cross-verified with existing research. The findings illustrated that the proposed model is capable of predicting fatal road accidents in the country, and this would benefit road safety stakeholders to make better decisions in favour of the safety of roadway users.

Keywords: Road accident; Road safety; Fatalities; Mathematical Model.

A Study on the Growth of Evolution Functions of the Dynamical System

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ABSTRACT

A dynamical system is a system in which a function describes the time dependence of a point in Euclidean space R_n or smooth manifold.

At a time t, a dynamical system is state space R_n along with an evolution rule (i.e. a function or differential equation) that describes what future states follow from the current state.

Many of dynamical system the evolution function are complex valued functions. In this article we study the growth of evolution function, those which are transcendental entire functions.

If $f(z)$, $g(z)$ and $h(z)$ are entire function then iteration of $f(z)$ with $g(z)$ and $h(z)$ are denoted by $f_n(z)$ and define by

$f_n(z)$ = f(g(h ..... (f(z) or g(z) or h(z) according as n=3m-2 or 3m-1 or 3m) .....))).

Here we study growth of $f_n(z)$ with respect to $f(z)$, $g(z)$ and $h(z)$.

Keywords: Dynamical system; evolution function; growth; iteration.

Advanced Techniques in Contact and Paracontact Metric Geometry

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ABSTRACT

This work offers a detailed comparative study of modern analytical techniques in the geometry of contact and paracontact metric manifolds. Using Cartan's equivalence method with the method of moving frames, we derive intrinsic invariants and establish curvature classification results on Sasakian and para Sasakian structures. Central to the investigation are (κ, μ)-nullity distributions and their analogues in the para-contact setting, which underpin recent rigidity theorems in contact and semi-Riemannian geometries. Additionally, we incorporate Monge–Ampère–type PDE methods on homogeneous para-Kähler contactifications to identify invariant geometric structures in para-contact regimes. A pivotal analytic tool is the contact Riemannian curl, a differential invariant that vanishes in constant curvature metrics or for contact structures defined by Killing forms—highlighting its projective invariance and connection to the Laplace–Beltrami subsymbol. Case studies in dimensions 5 and 7 demonstrate how these techniques distinguish Einstein-like, η Einstein, and nullity-induced geometries. The resulting framework reveals both methodological convergence and critical distinctions across contact and para-contact contexts, setting the stage for future research in geometric analysis and theoretical physics.

Keywords: Riemannian manifold; Contact manifold; Paracontact manifold; Cartan equivalence method; (κ, μ)-nullity; Einstein manifold.

Secret Sharing: Merging and More

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ABSTRACT

For safeguarding private information, which are often represented as finite field elements, for the ease of calculation, we often use a cryptographic primitive called *secret sharing* [1,2], where an impartial participant called the *dealer* distributes the secret in a (often finite) set of predefined *participants* in a manner that in absence of himself/herself a *qualified* coalition of shareholders may recover the secret. In [3], Slinko introduced how to merge to secret sharing schemes, which we further investigate and improve in this work.

Keywords: Secret Sharing; Cryptography; Information theoretic security.

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Some Characterizations of Spacetimes Admitting Different Types of Energy–Momentum Tensor

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ABSTRACT

The object of the present paper is to characterize spacetimes admitting different types of energy–momentum tensor. At first, we consider spacetimes with pseudo symmetric energy–momentum tensor T. We obtain a necessary and sufficient condition for a spacetime with pseudo symmetric energy–momentum tensor to be a pseudo Ricci symmetric spacetime. Next, we consider the spacetimes with Codazzi type of energy–momentum tensor and several interesting results are pointed out. Moreover, some results related to perfect fluid spacetimes with different forms of energy–momentum tensors have been obtained. We study spacetimes with quadratic Killing energy–momentum tensor T and show that a GRW spacetime with quadratic Killing energy–momentum tensor is an Einstein space. Finally, we have considered general relativistic spacetimes with semisymmetric energy–momentum tensor and obtained some important results.

Keywords: Perfect fluid spacetime; Einstein's field equation; Energy–momentum tensor; Codazzi type tensor.

Some Aspects of Additively Completely Regular Seminerrings

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ABSTRACT

One nice aspect of studying additively regular seminearrings is to obtain semigroup theoretic analogues. In this connection it may be recalled that there are some important structure theorems, in general for regular semigroups, in particular for completely regular semigroups and for Clifford semigroups. In this paper an attempt has been made to obtain some sort of analogue of structure theorem of Clifford semigroups in the setting of seminearrings. To accomplish this, the notion of strong bi-semilattice of seminearrings has been introduced. Then those left (right) Clifford seminearrings, which are strong bi-semilattice of near-rings (zero-symmetric near-rings) and strong distributive lattice of near-rings (zero-symmetric near-rings) have been characterized.

Keywords: *E*+-unitary seminearring; strong bi-semilattice of (zero-symmetric) near-rings; strong distributive lattice of (zero-symmetric) near-rings.

Set-Valued Minimax Programming Problems with Higher-Order σ-Cone Arcwise Connectedness

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ABSTRACT

In the last decade, many results of minimax programming problems have been extended to set-valued minimax programming problems. Many problems in mathematical economics, viability theory, image processing, and many more can be analyzed as set-valued minimax programming problems.

We consider a set-valued minimax programming problem (P) which is to

$$\min_{p \in M} \max \bigcup_{q \in N} \psi(p, q),$$

subject to $\omega(p) \cap (-\boldsymbol{R}_k^+) \neq \Phi$,

where M is a nonempty subset of R^i, N is a nonempty compact subset of R^j, $\psi : \boldsymbol{R}^i \times \boldsymbol{R}^j \to 2^{\boldsymbol{R}}$ and $\omega : \boldsymbol{R}^i \to 2^{\boldsymbol{R}^k}$ are two set-valued maps.

In this paper, we introduce the notion of higher-order σ-cone arcwise connectedness of set-valued maps as a generalization of higher-order cone arcwise connected set-valued maps. We establish the sufficient optimality conditions of the problem (P) by using higher-order contingent epiderivative and higher-order σ-cone arcwise connectedness assumptions. We also study the higher-order weak, strong, and converse duality theorems of Mond-Weir, Wolfe, and mixed types.

Keywords: Set-valued map; Arcwisely connectedness; Contingent epiderivative; Duality.

Nonlinear Radiative Heating of Blood-Based Hybrid Nanofluid with Laser Absorption for Photothermal Cancer Therapy

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ABSTRACT

This work presents a computational study on the thermal response of blood-based hybrid nanofluids infused with single-walled and multi-walled carbon nanotubes (SWCNTs and MWCNTs) when exposed to laser irradiation—targeting advancements in photothermal cancer therapy. By adopting the Beer–Lambert law to model internal laser energy absorption and applying a convective boundary condition to simulate tissue–blood thermal interactions, the study delivers a robust framework for localized heating analysis. Nanoparticle motion due to Brownian effects and thermophoresis is modelled via the Buongiorno approach, allowing simultaneous evaluation of heat and mass transfer behaviours. The system's nonlinear boundary-layer equations are reduced using similarity transformations and solved numerically using the shooting method alongside a 4th-order Runge–Kutta algorithm. Results demonstrate that tailored adjustment of laser intensity and hybrid nanoparticle concentration can substantially elevate local temperature, with a recorded Nusselt number increase of approximately 15% over pure blood. Notably, precise control of the Biot number and particle loading enables therapeutic hyperthermia (42–45 °C), highlighting the model's practical relevance for designing efficient, minimally invasive laser-assisted treatment protocols. These findings underscore the clinical promise of hybrid nanofluids in achieving targeted thermal ablation of cancerous tissues.

Keywords: Hybrid Nanofluid; SWCNT; MWCNT; Beer–Lambert law.

Bifurcation and Stability Analysis of In-vivo HIV Infection Model with Effect of Cytotoxic T-lymphocytes and Beddington-DeAngelis Incidence Rate and Linear Cure Rate

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ABSTRACT

We have studied a four compartmental disease model to identify the in-vivo HIV-infection spreading pattern in deterministic environment with logistic proliferation rate for both non-infected and infected CD4+ T-cells and Beddington–DeAngelis type incidence rate, linear cure rate and effect of HIV-specific CTLs. The deterministic system has at most three CTLs-containing endemic equilibrium points along with the disease-free equilibrium and the CTLs-free endemic equilibrium points. We have studied local and global stability criteria of the different equilibrium points in terms of the basic reproduction number as well as some of the model parameters. The ODE-system experiences Transcritical and Saddle-node bifurcation with respect to some of the model parameters. Using numerical simulation, we have studied the nature of the solutions in one parameter and two parametric planes. It is clear from the simulation results that with the increment of rate of infection and proliferation rate, the controlling of the disease becomes more difficult.

Keywords: HIV infection; Cytoxic T-lymphocytes; Transcritical bifurcation; Saddle-node bifurcation.

On the U-shaped Vortex Structures in the Lid-driven Cavity Flow

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ABSTRACT

U-shaped vortices are the components of large-scale coherent structures, which significantly influence the flow transition from laminar to turbulent regimes. This work mainly aims to identify the traces of U-shaped vortices in the lid-driven cavity flow by employing different vortex identification methods. According to the results obtained from our direct numerical simulation (DNS), we observe two different types of U-shaped vortices in the flow regime: Bottom and Upstream U-shaped vortices. This is probably the first time that the observation of upstream U-shaped vortices has been reported. We also discuss the effect of kinetic energy and the role of corner vortices on the formation of those vortices in the cavity. The physical connectivity between U-shaped, Taylor-Görtler-like (TGL), and mushroom-shaped vortices is also discussed in this work.

Keywords: U-shaped Vortices; Vortex Identification; TGL Vortices; Mushroom-shaped Vortices.

Integrating Machine Learning and Survival Analysis to Model the Spread of Disease in Low-Resource Environments: A Simulation-Based Approach

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ABSTRACT

Due to inadequate infrastructure, missing data, and a shortage of medical professionals, global health systems in low-resource environments faced challenges in monitoring the progression of diseases. This study models the time it takes for events to occur using both traditional survival analysis and machine learning on a simulated survival dataset that represents patients in underserved regions. Random Survival Forests (RSF) and Cox proportional hazards models were compared using discrimination criteria such as the concordance index. The findings show that, despite only slightly outperforming classical models in prediction, machine learning models offer greater adaptability to complex interactions and non-linearity. This integrative modelling approach has the potential to provide real clinical decision support in settings with limited resources.

Keywords: Concordance index; Cox proportional hazard model; Low-resource settings; Random survival forest.

Disease Progression Modelling in Presence of Measurement Error in Covariates

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ABSTRACT

While recording observations longitudinally in many epidemiological and clinical studies, the variables of interest are often measured with certain error, which in turn, if left uncorrected, leads to biased parameter estimates and invalid inferences and justifications. Measurement error arises from various sources, such as inaccurate inclusions due to high costs, which may help bear the precise measurement results, relying on surrogate versions of the variables, or the imperfect recall memory of the participants involved in the study. Sometimes disease status is recorded using ordinal scale. To model a longitudinal ordinal data, a marginalized modelling framework has been proposed that adjusts the likelihood function which accounts for the covariate measurement error. The estimation strategy is referred to as the Monte-Carlo Newton-Raphson Expectation Maximization (MCNREM) algorithm. The proposed approach accounts for the measurement error in covariates for the analysis of longitudinal ordinal data, giving estimation accuracy and providing a useful framework for a disease progression study.

Keywords: Longitudinal data; Marginalized model; Measurement error; Metropolis Hastings Newton Raphson.

Optimal Allocation of Experimental Units with Known Covariates Under Block Design Using an Improved Variable Neighborhood Search Algorithm

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ABSTRACT

The optimal allocation of experimental units possessing known covariate information into treatment groups is a critical component in the design of randomized clinical trials and intervention studies. While numerous studies have addressed this problem under completely randomized designs, the incorporation of blocking factors as in Randomized Block Designs (RBD) introduces additional layers of complexity, rendering the search for optimal allocations computationally intractable through exhaustive methods. This paper proposes an enhanced Variable Constrained Neighborhood Search (VCNS) algorithm designed to address the optimal allocation problem under block design settings, considering both balanced and unbalanced allocation structures. The proposed algorithm seeks to maximize efficiency under standard optimality criteria, including D- and A-optimality, within the framework of an analysis of covariance (ANCOVA) model. The method is also shown to be compatible with Balanced Incomplete Block Designs (BIBD), defined by five key parameters (b, k, v, r, λ), and satisfying necessary combinatorial constraints. Simulation studies and real-life applications, such as animal husbandry and agricultural experiments, demonstrate the performance of the algorithm compared to random allocation and existing neighborhood search methods. The findings suggest that the VCNS algorithm offers a robust and scalable solution to optimal allocation problems in complex experimental settings.

Keywords: Variable Neighborhood Search; Block Design; D-optimality; Iterative Algorithm.

Production Inventory under Delay in Production Due to Machine Failure and Re-Production to Retain the Customer with Carbon Emission

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ABSTRACT

This paper proposes an Economic Production Quantity (EPQ) model addressing production delays due to machine failure under price-dependent demand in a re-production cycle. It incorporates carbon emission costs, eco-friendly packaging, and green investments in holding and production. The planning horizon is divided into three phases: pre-failure (normal production), during failure (sales from existing stock), and post-repair (resumed production). The model is validated with a numerical example, sensitivity analysis, and managerial insights.

Keywords: Sustainability; Production inventory; Machine breakdown; Carbon emission; Green Investments; Eco-Friendly Packaging.

Analytic Derivations of Power Sum Formulas via Contour Integration: Special Focus on Cubes and Faulhaber's Formula

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ABSTRACT

This paper explores the use of advanced mathematical methods, specifically contour integration, to prove the identity $1^3 + 2^3 + 3^3 + \ldots + n^3 = \left\{\frac{n(n+1)}{2}\right\}^2$. We also derive Faulhaber's formula for summing integer powers. By incorporating Bernoulli numbers and Cauchy's infinite product representation, our method offers a more in-depth analytic understanding of classical results. This approach not only integrates existing techniques but also reveals inherent connections with special functions in number theory.

Keywords: Faulhaber's Formula; Bernoulli Numbers; Contour Integration; Sums of Powers of Integers.

An EPQ Model for Deteriorating Items with Stock-Dependent Demand Under Preservation Technology

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ABSTRACT

This paper develops a production-inventory model for a deteriorating item with stock-dependent demand under two storage facilities and completely backlogged shortages using preservation technology over an infinite time horizon. For display and storage of inventory, one warehouse of finite capacity is located at the main market, called primary warehouse (PW) and another warehouse with large capacity at a small distance from the main market, called secondary warehouse (SW). Here I consider items are transported from SW to PW in continuous release pattern and the transportation cost is negligible. The aim of this study is to obtain the optimal cycle length for maximum average profit through a genetic algorithm (GA). To illustrate the model and to show the effectiveness of the proposed approach a numerical example is provided. A sensitivity analysis of the optimal solution with respect to the parameters of the system is carried out.

Keywords: Inventory; Deterioration; Preservation technology; Stock-dependent demand; Genetic algorithm.

A Cosmological Holographic Reconstruction of f(Q)

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ABSTRACT

This work explores a cosmological reconstruction scheme in the background of f(Q) gravity theory from a Holographic perspective. The basic motivation for this work is that the reconstruction is performed from a holographic origin, which has its roots in the black hole thermodynamics and quantum gravity. Dark energy models inspired by holographic prescription are used to reconstruct the f(Q) gravity models. Two such models, namely, the Granda-Oliveros holographic dark energy model and its generalization, the Chen-Jing model, are considered for the study. Different scale factors are used and a thorough reconstruction scheme is set up using the dark energy models. The observationally constrained values of the free model parameters have been used to form the reconstructed models. Finally, a thorough investigation of the energy conditions has been performed to check the cosmological viability of the reconstructed f(Q) models. As an outcome, we get some very promising and cosmologically viable f(Q) models that present some interesting properties and demand further investigation. Finally, a method is discussed how the constructed f(Q) models can be reconciled with a generalized holographic dark energy.

Keywords: Holographic; Reconstruction; Modified gravity; Dark energy.

Study of Oscillations in a Two Patch SIR Model

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ABSTRACT

A two patch SIR model is considered where the rate of human migration is often regulated by the intensity of the current disease prevalence. We show that the incorporation of migration causes oscillation in the disease dynamics. Our investigation reveals that the model exhibits a transition from stable endemic to oscillatory dynamics and then again stable endemic state. We also investigate the interplay between migration and awareness parameters on the dynamics of the system. One key observation is that oscillation in the dynamics of the system is always prevented by two distinct patches with the same disease transmission. Additionally, the effect of migration between two identical patches on the dynamics of the system is observed. Ultimately, this study has shown that oscillation in the system is not always present in two distinct SIR patches with nonlinear migrations; this depends on both patches' migration patterns and rates of disease transmission.

Keywords: Hopf-bifurcation; Migrations; Oscillations; SIR model.

Exploring Cosmic Acceleration through the Holographic Reconstruction of Modified Gravity Theories

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ABSTRACT

The observed acceleration of the universe has motivated cosmologists to explore alternatives to General Relativity and the standard cosmological model. In this talk, we delve into holographic reconstruction techniques within the framework of modified gravity, focusing particularly on f(T) and scalar-tensor theories such as Chameleon Brans–Dicke cosmology. Drawing inspiration from the holographic principle, we examine how dark energy models, especially those involving infrared (IR) cutoffs, can be used to effectively reconstruct viable modified gravity theories. Special attention is given to extended and modified holographic Ricci dark energy models, which allow for a richer cosmological evolution and a natural explanation for both early-time inflation and late-time acceleration. We explore observational diagnostics, including the state finder parameters and the evolution of the deceleration parameter, to distinguish these models from the standard ΛCDM scenario. The role of scalar fields and their interaction with matter is highlighted, particularly in the context of generalized Brans–Dicke models with non-minimal coupling. This unified approach not only deepens our understanding of dark energy but also provides a compelling case for the viability of modified gravity as a foundational framework for modern cosmology.

Understanding Dengue Epidemics Through Sensitivity and Bifurcation Analysis

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ABSTRACT

Dengue fever, caused by mosquitoes, is a global health threat, especially in tropical and subtropical regions. Understanding disease processes and assessing intervention efforts requires mathematical models. This study examines a dengue epidemic model to determine which factors affect illness propagation and how the model reacts to these factors. We created dengue transmission SEIR and mosquito SEI models. We employed Latin Hypercube Sampling (LHS) and PRCC sensitivity analysis to prioritize parameters. Our focus was on how model parameters impact R_0 and disease prevalence. Dengue dynamics were driven by mosquito bite rate, mosquito survival, and viral transmission from mosquito to person, according to our study. A bifurcation analysis was performed to investigate key parameters and equilibrium point stability. Our analysis reveals that there are two types i.e. transcritical and Hopf bifurcations, which relate to quick shifts in how the disease spreads and its behaviour at certain important points. These bifurcations show that key thresholds modify disease dynamics and may cause chronic oscillations or elimination. The most essential insights from this investigation form the basis for effective public health intervention programs. Understanding bifurcation points will assist in predicting outbreaks and acting proactively to avert endemic situations or suppress oscillatory behaviour. This study fills a gap in dengue epidemiology and supports disease management and control measures.

Keywords: Dengue; Epidemic; Bifurcation; PRCC.

On Single Controller Semi-Markov Games Under Limiting Ratio Average Payoff

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ABSTRACT

Limiting ratio average (undiscounted) payoff is considered for a zero-sum two-person finite (state and action spaces) semi-Markov game (SMG) where the transition function and the timing of transitions are controlled by a single player in all states (such games are called single controller SMGs). The existence of an optimal semi-stationary strategy for each player is proved. A crude but finite step algorithm is given to compute such an optimal strategy pair.

Keywords: Semi-Markov games; limiting ratio average payoff; single controller; optimal semi-stationary strategies.

Effect of Electron Nonthermality on Nonlinear Dust Acoustic Wave Propagation in a complex plasma in Presence of Secondary Electron Emission when Equilibrium Dust Charge Is Negative

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ABSTRACT

In this paper effect of electron nontermality on nonlinear dust acoustic wave propagation in a complex plasma has been studied in presence of secondary electron emission for both adiabatic and nonadiabatic dust charge variation considering equilibrium dust charge negative. In this paper investigation shows that in case of adiabatic dust charge variation dust acoustic soliton is rarefied in nature whose amplitude decreases , width increases with increasing secondary electron yield at fixed nonzero electron nonthermality whereas amplitude increases and width decreases with increasing electron nonthermality at fixed secondary electron yield . In case of nonadiabatic dust charge variation at fixed non zero electron nonthermality increasing secondary electron emission suppresses oscillation of oscillatory dust acoustic shock at weak nonadiabaticity and pronounces monotonicity of monotonic dust acoustic shock at strong nonadiabaticity. On the other hand at fixed secondary electron yield and increasing electron nonthermality opposite behaviour of dust acoustic shock is seen. This situation pronounces oscillation of oscillatory dust acoustic shock at weak non adiabaticity and suppresses monotonicity of monotonic dust acoustic shock at strong nonadiabaticity. The nature of dust acoustic soliton and dust acoustic shock remain unchanged if both electron nonthermality and secondary electron yield are increased. No unstable character has been found from this model.

An Optimized Low-Dissipation Low-Dispersion Explicit Runge-Kutta Method for Wave Equations

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ABSTRACT

In this work, an accurate and efficient time advancing method is presented for computational acoustics where non-dissipative and non-dispersive properties are of critical importance. This paper is devoted to the optimization of the explicit fifth stage third order Runge-Kutta (R-K) method in order to obtain low-dissipation and low-dissipation errors for wave propagation as the stability consideration alone is not sufficient for computing acoustic waves. The method is dependent on two free parameters used for the optimization. This proposed scheme is obtained by minimizing both dissipation and dispersion errors which is more efficient than the classical R-K scheme for acoustic computations. The application of the proposed R-K scheme along with higher order finite difference discretization for spatial derivatives is also analysed. The efficiency of the newly constructed method is shown through the numerical results.

Keywords: Time integration; Explicit Runge-Kutta; Wave propagation; Low-dissipation low dispersion.

Influence of Multislip Conditions on Casson Nanofluid Flow Over a Stretching Cylinder Under Solar Radiation Effects

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ABSTRACT

This study investigates the unsteady, axisymmetric flow of a Casson nanofluid around a contracting, non-permeable cylinder influenced by solar radiation. A comprehensive slip condition is incorporated into the model. By applying suitable similarity transformations, the governing equations are reduced to a system of non-linear ordinary differential equations, which are then solved numerically using the Runge-Kutta-Fehlberg method via Maple 18 software. The influence of key physical parameters on the flow behaviour is analyzed and illustrated using tables and graphical representations, supported by detailed discussion and physical interpretation. Notable effects of various slip conditions on essential physical quantities are observed. An increase in surface slip tends to elevate the temperature profile while reducing the flow velocity. In contrast, thermal slip results in a decrease in fluid temperature but leads to an increase in the heat transfer rate.

Keywords: Casson nanofluid; solar radiation; multiple slips; Slip condition

Modeling Hybrid Nanofluid Dynamics with Variable Permeability of Darcy-Forchheimer Resistance and Radiative Heat Transfer in a Porous Structure

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ABSTRACT

This investigation addresses the unsteady, laminar motion of an incompressible hybrid nanofluid flowing through a porous medium. The medium's structure is characterized by spatially varying porosity and permeability, governed by the Darcy-Forchheimer drag formulation to capture both linear and inertial resistance effects. A suspension combining magnesium oxide (MgO) and ferric oxide (Fe_3O_4) nanoparticles dispersed in engine oil forms the working fluid, enhancing thermal conductivity while maintaining appropriate flow characteristics. Additionally, the study incorporates the impact of linear thermal radiation, reflecting realistic heat transfer conditions relevant to industrial applications. The governing nonlinear differential equations derived from the physical model are solved numerically using the classical fourth-order Runge-Kutta method in conjunction with a shooting technique to satisfy boundary conditions. The results provide insight into the influence of porosity variations, Forchheimer drag, and hybrid nanoparticle concentration on the heat and momentum transfer within the system.

Keywords: Hybrid nanofluids; Variable permeability; Darcy-Forchheimer; Radiation.

Stability and Bifurcation Analysis of a Discrete Prey-Predator Model with Fear Effect, Additional Food and Anti-Predator Behaviour of Prey with Chaos Control

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ABSTRACT

In this work, we formulate and analyze a two-dimensional prey–predator dynamical model that incorporates several ecologically significant factors affecting the prey population. Specifically, the model accounts for logistic growth of prey, the influence of predator-induced fear, the presence of additional food resources, and anti-predator behavioral adaptations of the prey. The interaction between the predator and prey populations is governed by a Holling type II functional response. The model is designed to explore how the combined effects of fear, supplemental feeding, and defensive behavior influence the dynamics and stability of the system. A comprehensive mathematical analysis is carried out to examine the existence, feasibility, and local stability of various equilibrium points. To understand the complex dynamical behavior, we investigate Neimark–Sacker bifurcation and the emergence of chaos with respect to changes in the handling time ratio, a key ecological parameter. Our theoretical results are further supported by detailed numerical simulations, which illustrate the model's rich dynamics under varying ecological conditions. In the latter part of the study, we propose a bifurcation control mechanism by which we can advanced or delay bifurcation at desired position and even chaos can be eliminated., which may have practical implications for ecological management and conservation planning.

Keywords: Discrete predator prey system; Neimark-Secker bifurcation; Bifurcation control.

Thin-Shell Wormhole from Modified Bardeen AdS Black Hole

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ABSTRACT

This study investigates the construction and stability of thin-shell wormholes derived from the modified Bardeen Anti-de Sitter (AdS) black hole. The thin-shell wormhole is constructed using Visser's cut-and-paste method, which involves matching two identical black hole spacetimes at a hypersurface to form a throat that connects the geometries. Wormhole's stability is examined through the Israel formalism, which provides the surface stress-energy tensor at the throat. The violation of energy conditions, a hallmark of exotic matter, is explored in detail. Linearised stability analysis is performed by perturbing the wormhole throat and analysing the resulting equations of motion. Various equations of state (EoS), including barotropic, generalised phantom-like, and generalised Chaplygin gas models, are considered to study the behaviour of the system under radial perturbations. Our findings demonstrate that a thin-shell wormhole's stability strongly depends on the throat radius, charge parameters, and cosmological constant. Furthermore, the influence of EoS parameters is crucial in determining the stable and unstable configurations of the wormhole. This study highlights the critical role of modified black hole geometries in constructing physically viable and stable wormhole solutions in the context of AdS spacetimes.

Keywords: Thin-shell wormhole; EoS; Cosmological constant; Israel's junction conditions.

Bridging Mechanics and Machine Learning: High-Accuracy Beam Deflection Modeling

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ABSTRACT

This study presents a **deep learning-based approach** for analyzing beam deflection by embedding fundamental mechanical principles. The model optimizes a composite loss function derived from both physical constraints and empirical data. Comparative evaluations with classical analytical methods confirm superior accuracy, computational efficiency and adaptability to complex structural scenarios. The results highlight this methodology promising for data-enhanced engineering solutions in civil infrastructure.

Influence of Interfacial Piezo-Membrane on Shear Horizontal Wave Dynamics in a Complex Fluid–Piezoelectric Configuration

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ABSTRACT

In this paper, the propagation of Shear Horizontal (SH) waves in a multilayered system with a complex fluid layer on top of a piezoelectric half-space and an imperfect interface with piezo-membrane properties between them is thoroughly investigated. This interface is designed to simultaneously reflect mechanical compliance and piezoelectric coupling effects, capturing the intricate interactions at the fluid-solid boundary. The study allows for a detailed parametric analysis of how important physical parameters, such as mass densities, dielectric constants, elastic and piezoelectric moduli, and others, control the phase velocity and attenuation of SH waves by obtaining closed-form analytical expressions for the dispersion relation. As far as we are aware, this is the first investigation into the propagation of SH waves in a complicated fluid-loaded piezoelectric system that takes interfacial piezoelectric effects into consideration. The results demonstrate the interfacial piezo-membrane's significant impact on wave dynamics and point to its potential as a tuning mechanism in next-generation piezoelectric waveguides, acoustic biosensing platforms, advanced microelectromechanical systems (MEMS), and structural health monitoring technologies.

Keywords: Shear Horizontal (SH) waves; Complex fluid; Piezoelectric; Piezo-membrane.

Characteristics of Generalized Kenmotsu Space Form Admitting ⋆-Conformal η−Ricci Soliton

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ABSTRACT

In this paper we have charcterized Generalized Kenmotsu Space form admitting ⋆-Conformal η−Ricci Soliton. The next section is to deliberate a brief discussion on the above class of manifolds. In continuation to this we have given few preliminary ideas on Generalized Kenmotsu Space form. Among others we have proved several conditions under which Generalized Kenmotsu Space form is an η−Einstein manifold. We have given a brief discussion on Generalized Quasi-conformal curvature tensor and have also given a crucial result on the said space form.

Keywords: Generalized Kenmotsu Space form; Ricci soliton; ∗-Conformal η-Ricci soliton; η−Einstein manifold; Generalized Quasi-conformal curvature tensor.

Local and Global Dynamics of a Fractional-Order Predator-Prey System with Habitat Complexity and the Corresponding Discretized Fractional-Order System

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ABSTRACT

This paper is focused on local and global stability of a fractional-order predator-prey model with habitat complexity constructed in the Caputo sense and the corresponding discrete fractional-order system. Mathematical results like positivity and boundedness of the solutions of fractional-order predator-prey model is presented. Conditions for local and global stability of different equilibrium points are proved. It is shown that there may exist fractional-order-dependent instability through Hopf bifurcation. We have determined an extra stability region in the lower range of habitat complexity where all populations coexist in stable state for some fractional-order values but unstable for integer-order value. Dynamics of the discrete fractional-order model is shown to be more complex and depends on both the step-size and fractional-order. It shows Hopf bifurcation, flip bifurcation and chaos with respect to the step-size. Several examples are presented to substantiate the analytical results.

Keywords: Fractional differential equation; Ecological model; Local & Global stability; Discrete fractional order model; Bifurcations.

Some Results Due to Uniqueness of Meromorphic Functions Concerning Non-Linear Differential Polynomials

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ABSTRACT

In this paper, we deal with the uniqueness problems on meromorphic functions concerning non-linear differential polynomials with regard to multiplicity. Moreover, we greatly generalize and improve some results obtained by V. Husna [J. Anal.,29 (2021), 1191-1206].

Keywords: Uniqueness; Differential polynomial; Meromorphic function; Weighted sharing.

On the Growth Rate of Composite Entire Algebroidal Functions in the Light of p-Adic Analysis

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ABSTRACT

The primary objective of this paper is to investigate the comparative growth behaviour of the composition of two k-valued entire algebroidal functions through the lens of p-adic analysis. Emphasis is placed on examining their growth in terms of generalized relative growth indicators. Specifically, we aim to characterize the growth rates of such functions based on the framework of *generalized relative order* (α, β) , where α *and* $\beta$are non-negative continuous functions defined on $(-\infty, \infty)$. This approach not only extends classical growth theories but also provides a broader perspective on the asymptotic analysis of p-adic entire algebroidal functions.

Keywords: Entire algebroidal function; growth; p-adic entire function; *generalized relative order* (α, β).

Exploring Order-Congruence Graphs and Their Polynomial Representation

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ABSTRACT

Order-congruence graph, denoted by $C_o(Z_n)$ is a graph associated to the commutative ring Z_n. The elements of the ring Z_n are considered as the vertices of $C_o(Z_n)$, where any two distinct vertices a and b are adjacent in $C_o(Z_n)$ whenever $a + b \equiv 0(mod\ n)$ or $a.b \equiv 0(mod\ n)$ with $b \neq n - a$, where n is the order of Z_n. Some new definitions associated to $C_o(Z_n)$ namely conjugate pair and free-element are also introduced. For a simple graph G , having $\Delta(G)$ as its maximum degree , the polynomial representation of G , denoted by $P_G(x)$, is a polynomial over Z of the form $P_G(x) = \sum_{i=0}^{\Delta(G)} a_i\, x^i$, where a_i is the number of vertices in G with degree i for each $i = 0,1,2, \ldots \ldots \Delta(G)$.

Some interesting results on $C_o(Z_n)$ can be derived using these definitions. Besides that, some interesting structural properties of $C_o(Z_n)$ are also studied.

In this paper we explore various properties of $C_o(Z_n)$ and their polynomial representations.

Keywords: Order-congruence graph; Conjugate pair; Free-element; Polynomial representation.

Accelerating Holographic Ricci Pilgrim Dark Energy (HRPDE) in General Relativity (GR)

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ABSTRACT

In this paper, we have investigated the Holographic Ricci Pilgrim Dark Energy (HRPDE) in the framework of Kantowski-Sachs cosmological model. To prevail on the deterministic solutions, we choose the deceleration parameter q as a linear function of the Hubble parameter H which generates the transition of the Universe from the early decelerating phase to the recent accelerating phase. The evolution of various parameters such as matter energy density ρ_m, HRPDE density ρ_p, deceleration parameter q, anisotropy parameter A_p, equation of state (EOS) parameter ω_p etc. have been described in the form of figures. $\omega_p \to -1$ indicating HRPDE model behaves like a cosmological constant. Additionally, energy conditions and stability analysis of the cosmological model have been investigated. In the context of the present model, the evolution of the Universe and other physical aspects were discussed.

Keywords: HRPDE; matter energy density; EOS parameter; energy conditions.

Modelling And Analysis of an Epidemic System with Media Awareness Incorporating PRCC Analysis and Optimal Control Under Caputo Type Fractional Derivative

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ABSTRACT

An investigation of the transmission way of infectious diseases with the population's memory effect has been conducted using a three-compartmental fractional-order epidemic framework. The existence and uniqueness requirements for the solution of the fractional-order model are confirmed. The basic reproduction number $\mathcal{R}_0$ is a threshold value that is generated by using the next-generation matrix approach. It has been established that there are two equilibrium points in the model: endemic and disease-free. The suggested system's local asymptotic stability at the equilibrium points has also been examined. It has been shown that the fractional order of the model, which reflects the population's memory, affects the overall amount of infections during the persistence of the virus. It is further observed that when the numerical value of the basic reproduction number exceeds unity, a transcritical bifurcation is seen around the disease-free equilibrium point. Additionally, three different disease intervention policies, namely, vaccination, media awareness, and treatment, have been examined in order to study a fractional-order optimal control issue. A cost-effectiveness analysis has also been performed to establish the policies that will limit the spread of infections. Finally, MATLAB software has been used to do certain numerical simulations in order to validate analytical conclusions.

Keywords: Fractional-order epidemic model; Treatment and vaccination; Optimal control; Cost effectiveness analysis; Global sensitivity analysis.

Network Nonlocality Without Entanglement of All Sources

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ABSTRACT

Entanglement and nonlocality are two important nonclassical features of quantum correlations. Recently the study of quantum correlations in networks has undergone remarkable progress. However, compared to standard Bell scenario, manifestation of the interplay between these two aspects has received less attention in network scenarios featuring independent sources. In this work we have analysed the relation between entanglement content of the sources and detectable non-n-locality in two distinct network topologies (linear and star). We have studied the extremal violations of n-local inequalities (compatible with linear and star network) for any fixed amount of entanglement (in terms of concurrence) of the independent sources. It is observed that each of the sources must be entangled for detecting non n-locality in linear network. However, the same is not true for star n-local network. Present analysis is revealing that entanglement of all the independent sources is not a necessity for generation of non n-local correlations in star topology. Characterization of sources in terms of minimum entanglement requirement for any fixed violation amount of the n-local inequalities is also provided.

Keywords: Quantum Entanglement; Nonlocality; Networks.

On the Reflection of Thermoelastic Waves at a Stress-Free, Thermally Insulated Solid Surface with Memory Effects

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ABSTRACT

A two-dimensional generalized thermoelastic model is developed to investigate the reflection of plane waves in a stress-free, thermally insulated half-space composed of a thermally conducting, isotropic, and homogeneous elastic material. The analysis is carried out within the framework of the Lord–Shulman theory, incorporating a memory-dependent derivative in the heat conduction law. The study specifically addresses the case of total reflection to determine the critical angle of incidence.

Coupled thermoelastic wave phenomena are examined, focusing on the behavior of dilatational (longitudinal) elastic-thermal waves. The phase velocities and associated attenuation factors of these coupled waves are derived analytically. In addition, the amplitude ratios of the reflected waves, represented by reflection coefficients, are calculated.

To illustrate the physical behavior of the system under various conditions, numerical simulations are conducted, and the results are presented graphically. The influence of memory-dependent heat conduction on wave propagation characteristics is thoroughly analyzed. The model reveals how thermal and elastic fields interact at the boundary, providing insight into the complex mechanisms governing wave reflection in thermoelastic media with memory effects. These findings contribute to a deeper understanding of wave behavior in advanced thermoelastic materials and have potential applications in non-destructive evaluation, materials science, and thermal stress analysis.

Keywords: Memory; time-delay; P- and SV-waves; Dispersion.

Weighted Growth Signature Learning: A Deep Attention-Based Framework for Population Forecasting and Clustering

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ABSTRACT

Population forecasting is a fundamental aspect of demographic analysis and planning. However, conventional statistics models are often incapable of capturing the nonlinear and different growth patterns across regions and time. This study introduces Weighted Growth Signature Learning (WGSL), a novel deep learning architecture incorporating an attention-guided encoder-decoder structure, for simultaneously reconstructing historical population dynamics, forecasting future population values, while also learning latent growth signatures. This learned signature has two uses: reconstructing the historic time series and forecasting future population values, thereby allowing multi-task learning. To assess the model, we run experiments using real-world population from 1970-2020 for over 200 countries, as well as an inconvenient synthetic data set containing diverse simulated growth patterns (linear, exponential, logistics, plateau and declining). A comparative analysis of WGSL against classical Autoregressive Integrated Moving Average (ARIMA) models shows a substantial advantage in forecasting accuracy of WGSL compared with ARIMA and learning representations compared to Vanilla Autoencoders (VA). A comparative analysis against the real-world projections of United Nation & World Bank projections is also evaluated alongside with WGSL.

Keywords: Autoencoder; Deep Learning; Encoder-Decoder.

Some Results on the Uniqueness of Entire and Meromorphic Functions

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ABSTRACT

Let f and g be two non-constant meromorphic functions defined in the open complex plane $\mathbb{C}$. For $a \in \mathbb{C} \cup \infty$, if $f - a$ and $g - a$ have the same zeros CM (counting multiplicities) and IM (ignoring multiplicities) then we say that f and g share the value a CM or IM respectively. Similarly, f, g share ∞ CM or IM means that $1/f$; $1/g$ share 0 CM or IM respectively. The study of the relationship between two entire or meromorphic functions sharing certain values is the main theme of the uniqueness theory. In this paper we present some newly developed result based on the various kinds of sharing of values or sets between entire or meromorphic functions with their derivatives and many more.

Keywords: Entire function; Meromorphic function; Sharing; Uniqueness.

Exploring India's Fertility Transition: Prospects and Challenges

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ABSTRACT

India's fertility rate has declined significantly, reaching 1.9 births per woman in 2025—below the replacement level of 2.1. This fertility transition is evident in the pronounced decline in age-specific fertility rates (ASFR), especially among the youngest cohort (15-19), and highlights an increasing alignment with fertility patterns observed in OECD countries. The childbearing age is rising, particularly in urban areas, driven by delayed marriage, higher educational attainment, and increased female labour force participation. While these trends reflect women's empowerment, they are also associated with complications such as increased rates of infertility, high-risk pregnancies, and a shift in the overall demographic structure, most notably with an increase in infant mortality rate (IMF). This study employs a probabilistic approach to analyse recent ASFR trajectories for both urban and rural, highlight the heightened risks of IMF associated with delayed motherhood, and project future trends. Results reveal a persistent fertility decline across all reproductive ages, with a notable postponement of childbearing, thereby increasing the risk of IMF. Projections indicate that these fertility patterns will shift India's demographic structure from a predominantly young population toward an increasingly aged one. These transformations are expected to intensify the socioeconomic need for policies that address rising dependency ratios, potential labour shortages, and advocate for public education on fertility awareness, family-friendly workplace policies and elderly care.

Keywords: Fertility transition; Age-specific fertility rate (ASFR); delayed motherhood; Infant Mortality Rate (IMF).

Frontiers in Mathematics and Challenges

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ABSTRACT

Over the past several years, research in "frontier" areas of mathematics education has focused on underrepresented populations, technology and digital environments, particularly in the context of the developing world, and on the theories, methods, and tools that conduct and support such research. Recent "frontiers" include distance learning, particularly in the context of the COVID-19 pandemic, and the general focus on meeting the math and socioemotional needs of each student, teacher, and family. The goals of this working group will be to develop a shared definition of what it means to be a "leading leader" in mathematics education and identify several current and emerging areas ready for examination; discuss the methodological frameworks used by the contributing researchers and other working group members to investigate teachers' challenges in these areas and establish a network of researchers interested in conducting research on and developing existing frameworks for such contexts.

Keywords: Frontiers; Methodological approaches; Mathematics education.

On Generalized Soft Metric Spaces

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ABSTRACT

Firstly, we have introduced a generalized concept of soft metric spaces, named generalized soft metric space, based on soft points of soft sets, and some basic properties regarding generalized soft metric space are studied with examples. After that, we established a fixed-point theorem on generalized soft metric space.

Minimal Posets Realizing $\mathbb{Z}_2 \times \mathbb{Z}_{2^n}$ as Automorphism Group

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ABSTRACT

The study of minimal realizations of finite groups as automorphism groups of finite posets has attracted considerable interest in recent years. Given a finite group G, $\beta(G)$ denotes the smallest number of elements in a poset whose automorphism group is isomorphic to G. In this work, we investigate the value of $\beta(G)$ for the groups of the form $G = \mathbb{Z}_2 \times \mathbb{Z}_{2^n}$, where $n \geq 1$. We develop general structural techniques to study realizability and minimality, focusing on orbit decompositions under group actions and combinatorial constraints arising from antichain and chain structures in posets. These tools help restrict possible group actions and allow us to establish new lower bounds and constructions for $\beta(\mathbb{Z}_2 \times \mathbb{Z}_{2^n})$. Our approach blends theoretical techniques from poset topology and group theory with computational verification using SageMath. The results contribute to the broader program of understanding how group symmetries can be encoded in finite combinatorial structures.

Keywords: Finite; Automorphism; Realizability; Minimal.

On Annihilators of Intuitionistic Fuzzy Subsets of a Ring

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ABSTRACT

The notion of annihilators of intuitionistic fuzzy sets of rings are introduced. It has been proved that the left (right) intuitionistic fuzzy annihilator of a ring is a left (right) intuitionistic fuzzy ideal. Some properties on intuitionistic fuzzy annihilators are obtained.

Keywords: Intuitionistic fuzzy subset; Intuitionistic fuzzy left ideal.

Geometric Properties of (k, μ)-Contact Metric Manifolds and Their Curvature Characterizations

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ABSTRACT

In this paper, we investigate the geometric structure of (k, μ)-contact metric manifolds, a natural generalization of contact metric manifolds that satisfy a specific curvature condition involving constants k and μ. We explore the implications of this curvature condition on the manifold's local and global geometry, providing new insights into the behavior of the curvature tensor, Ricci tensor, and the Reeb vector field. Several characterizations of (k, μ)-manifolds are established, along with classification results under additional constraints such as the manifold being η-Einstein or admitting a certain type of symmetry. Examples are constructed to illustrate the diversity and richness of this class of manifolds. Our results contribute to a deeper understanding of the interaction between contact geometry and curvature conditions in the broader context of almost contact metric structures.

Keywords: (k, μ)-contact metric manifolds; Ricci tensor; η-Einstein.

A Comprehensive Analysis of the Hyper Zagreb Index on Plithogenic Product Intuitionistic Fuzzy Graph

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ABSTRACT

The study of Plithogenic product intuitionistic fuzzy graphs is between the crisp certainty and fluid ambiguity of mathematical structures, emerging as a vital area of research within fuzzy mathematics, as they can model uncertainty more effectively than traditional graphs. The Hyper Zagreb index is computed by summing the squares of the sum of the degrees of the vertices in a graph, focusing on the edges and their endpoints. It plays a vital role in mathematical chemistry, serving as an essential topological index in graph theory. This paper presents a novel concept: the Hyper Zagreb index applied to Plithogenic product intuitionistic fuzzy graphs. This framework integrates dyadic attributes of membership and non-membership values alongside the degree of the Plithogenic product intuitionistic fuzzy graph and the degree-based topological index, known as the Hyper Zagreb index. By doing so, the proposed index offers a more sophisticated representation of multi-dimensional uncertainty, paving the way for new opportunities and underscoring its potential in modelling complex systems. The Hyper Zagreb index on Plithogenic product intuitionistic fuzzy graphs serves as an effective tool for analysing the structural integrity and stability of networks. This methodology is particularly relevant in fields such as molecular structures, network branching and complexity, network analysis, and multi-criteria decision-making.

Keywords: Plithogenic product fuzzy graph; Plithogenic product intuitionistic fuzzy graph; Topological indices.

Control of Irreversibilities and Heat Transfer in Prandtl–Eyring Hybrid Nanofluid Flow over a Riga Plate

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ABSTRACT

A Riga plate, developed by Gailitis and Lielausis in 1961, features a flat surface embedded with alternating electrodes and magnets. Widely applied in aerospace, maritime engineering, and industrial processes, this study explores hybrid nanofluid flow over a vertical Riga plate, focusing on nanoparticle shape effects. The hybrid nanofluid uses engine oil with copper and zirconium dioxide nanoparticles of varying shapes: spheres, bricks, cylinders, and platelets. This research provides an in-depth analysis of irreversibility generation within the system. Numerical simulations indicate that increasing the Prandtl–Eyring parameter amplifies the entropy generation. Additionally, the radiative heat transfer rate, quantified by the Nusselt number, increases significantly—by 98.35% for platelet-shaped nanoparticles, followed by 94.99% (cylindrical), 89.07% (brick), and 85.03% (spherical). The results consistently demonstrate that platelet-shaped nanoparticles deliver superior thermal performance. Both computational data and graphical insights highlight their effectiveness in maximizing heat transfer and minimizing irreversibility.

Keywords: Vertical Riga plate; Prandtl Eyring hybrid nanofluid; Entropy generation; particle shape factor.

Numerical Investigation of Electroosmotically Regulated Casson Hybrid Nanofluid Flow in A Rotating Microchannel

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ABSTRACT

The analysis of hydrodynamic and heat transfer characteristics in rotating channels is crucial due to its relevance in engineering, geophysical, and biomedical fields. Such channel flows are commonly encountered in systems like centrifugal pumps, cyclone models, hemolysis monitoring, drug delivery systems, and Lab-on-CD platforms. Rotational microfluidic devices, in particular, are widely used in biomedical labs for precise flow control and effective mass separation, often influenced by electrokinetic effects. Motivated by these applications, this study investigates the electroosmotic flow of a non-Newtonian hybrid nanofluid in a spinning microchannel. Single-walled carbon nanotubes (SWCNTs) and magnetite (Fe_3O_4) nanoparticles are introduced into the bloodstream to form a hybrid nanofluid, aiming to harness their synergistic effects. The Casson fluid model addresses the non-Newtonian rheology of blood. The problem is mathematically formulated as nonlinear partial differential equations (PDEs) with boundary conditions. A suitable similarity transformation converts the PDEs into a system of nonlinear ODEs, which are then solved numerically using the inbuilt bvp4c command in MATLAB. The effects of key parameters are analysed through dimensionless primary and transverse velocities, as well as temperature profiles. Three-dimensional plots illustrate wall shear stress and heat transfer rate. To ensure accuracy, the results are compared with existing studies under the same conditions, showing strong agreement. This work supports the design and thermal management of miniaturised electronic and biomicrofluidic devices.

Keywords: Rotating channel; Ferro hybrid nanofluid; Casson fluid; Electro osmotic flow.

Davis–Wielandt Radius Inequalities for Operator Matrices on Hilbert Spaces

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ABSTRACT

In this paper, we develop several new inequalities that refine existing bounds for the Davis–Wielandt radius of bounded linear operators, with particular emphasis on structured 2×2 operator matrices acting on complex Hilbert spaces. These inequalities are expressed in terms of the numerical radius, operator norm, and other operator-theoretic constants. In particular, we show that,

$$\mathrm{dw}^2\begin{pmatrix} O & X \\ Y & O \end{pmatrix} \leq 4\, max\left\{\frac{1}{2}|||X|^2 + |Y^*|^2||^{\frac{1}{2}}|||X^*|^2 + |Y|^2||^{\frac{1}{2}}, ||X||^4, ||Y||^4\right\},$$

where, X and Y are bounded linear operator on Hilbert space.

Keywords: Davis–Wielandt radius; Hilbert space; Operator Matrix; Bounded linear operator.

Interrelation Between Uniform Convergence and Whitney Convergence in Ideal Context

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ABSTRACT

In this article we introduce the notions of I -discrete convergence for sequences of functions. We focus on establishing a relationship between I −Uniform and I −Whitney on continuous function Space. The main theorem of this paper states that the sequence $\{f_n\}$ of functions from $C(Y,Z)$ is I −Whitney convergent to f in $C(Y,Z)$ if and only if it is I −uniform convergent to f and there exists a closed countable compact set $K \subset Y$ such that if U is an open subset of Y containing K such that the sequence $f_n|(Y \setminus K)$ is I −discretely convergent to $f|(Y \setminus K)$.

Keywords: I-uniform convergence; I-Whitney convergence; I -discrete convergence.

Developments in Finite Element Method

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ABSTRACT

Finite element methods are numerical methods for approximating the solutions of mathematical problems that are usually formulated so as to precisely state an idea of some aspect of physical reality. A finite element method is characterized by a variational formulation, a discretization strategy, one or more solution algorithms and post-processing procedures. It is a numerical technique for finding approximate solutions to boundary value problems for partial differential equations. FEM subdivides a large problem into smaller, simpler, parts. The simple equations that model these finite elements are then assembled into a larger system of equations that models the entire problem. FEM then uses variational methods from the calculus of variations to approximate a solution by minimizing an associated error function.

In this paper, we study a historical perspective development of finite element methods (FEM) since 1941, with respect to solid mechanics. We present a historical overview beginning with the theoretical formulations and origins of the FEM, while discussing important developments that have enabled the FEM to become the numerical method. We study the development of the finite element method into four time periods: Firstly. (1941–1965) Early years of FEM; Secondly. (1966–1991) Golden age of FEM; Third. (1992–2017) Large scale, industrial applications of FEM and development of material modelling, and Fourth (2018–) the FEM technology for the current and future eras of FEM research.

Keywords: Numerical Analysis; Finite element method; domain; subdomain.

Cost-benefit Analysis of Discrete Markov Chain System Model

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ABSTRACT

The concept of the study is the statistical analysis of two dissimilar parallel configuration system models when a non-priority unit is in cold standby. Using a geometric distribution with different parameters, the main unit is initially functioning, and the other unit is reserved for cold standby when the main unit fails to function. The priority unit has three modes: normal (U), partial failure (P), and total failure (F), while the non-priority unit has two possible modes: normal (U) and total failure (F). Within the system structure, the highest priority is accordingly to both the operation and repair activities of the main (priority) unit, reflecting its significant role in maintaining overall system functionality. Whenever a unit fails, the master and assistant technician are always available with the system to repair the failed unit as soon as possible. Some significant measures of the system, i.e., steady-state transition probability, mean sojourn time, reliability, and busy period for master and assistant technicians, are examine at different scales of failure and repair rates. We constructed graphical representation at different levels to analyze the mean time to system failure (MTSF), availability of the system, and cost-benefit analysis of the system.

Keywords: Geometric distribution; Steady-state transition probability; Availability of the system; Cost-benefit analysis.

Reliability Determination of a Complex Engineering Item Under the Distributional Setup

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ABSTRACT

Analytical computation of reliability for any complex engineering item is not tractable. Earlier the discretization was the main approach for approximating system reliability for intractable cases. But it fails to satisfy the latter demand in terms of design parameters. Finding reliability using discretizing method, one cannot increase or decrease reliability according to their requirement. Objective of our work is to offer a different approach where one not only gets a clear idea about the extent of error but also can manipulate in terms of design parameters. Here we have studied bound based reliability approximation under the Weibull frame work. Numerical study, for a selective choice of the Weibull shape parameter, ensures sharpness in the reliability bounds and establishes thereby the usefulness of this bound-based reliability approximation. Since design parameters can be adjusted as per requirements in this method, it can be of practical use during early stages of product design. Numerical studies of this approach have also been cited. Numerical studies indicate that the proposed technique gives very good approximation of reliability of complex systems under stress-strength set-up. This technique is conceptually simple, handles analytic intractability and reduces computational time. This technique can be employed in manufacturing industries for production of high-reliable items.

Key words: Reliability approximation; Reliability bounds; Stress strength analysis; Weibull distribution.

Fuzzy Closure-Like Operator Via Fuzzy Preopen Set

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ABSTRACT

In 1965, L.A. Zadeh introduced fuzzy set as follows: A fuzzy set is a mapping from a non-empty set X into the closed interval I= [0, 1]. In 1968, C.L. Chang introduced fuzzy topology. Afterwards, many mathematicians have engaged themselves to introduce different types of fuzzy open and closed like sets. In this context we have to mention fuzzy preopen set which was introduced by S.Nanda in 1991. Using this concept as a basic tool, here we first introduce p*-closure operator which is stronger than fuzzy preclosure operator [3]. It is also proved that p*-closure operator is not an idempotent operator, in general, but seems to be an idempotent operator in fuzzy p*-regular space. The interrelations of this operator with the operators defined earlier are established here. Lastly, we characterize this operator via fuzzy net.

Keywords: Fuzzy preopen set; fuzzy p*-closure operator; fuzzy p*-regular space; p*-convergence of a fuzzy net.

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Modelling Drug Distribution in Atherosclerotic Arterial Walls with Receptor and Non-Specific Binding

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ABSTRACT

Background: This study investigates how non-specific binding affects drug transport through receptors within atherosclerotic plaques during drug-eluting stent (DES) therapy. **Hypothesis:** We propose that incorporating non-specific and saturable receptor binding into a quantitative model will enhance predictions of drug distribution and retention in heterogeneous arterial tissues. **Materials and Methods:** A comprehensive model is developed to simulate drug diffusion, convection, and reaction within layered arterial tissues, considering dosage, receptor saturation, and experimentally derived binding kinetics. The arterial wall is modelled as a two-layer system (plaque and healthy tissue), each with distinct diffusivities and containing free, receptor-bound, and non-specifically bound drug states. The model also captures time-dependent release from DES and transport through the porous arterial environment. **Results:** Simulations reveal that key factors—such as drug-receptor dissociation rates and the initial drug load in the stent coating—strongly affect drug distribution and residence time across tissue layers. Non-specific binding significantly alters local drug availability and retention. **Conclusion:** This model highlights the importance of including non-specific binding and tissue heterogeneity to more accurately represent drug dynamics during DES therapy. These findings can help optimize stent design and improve therapeutic outcomes.

Keywords: Atherosclerosis; Drug-eluting stent; Marker-and-Cell (MAC) Method; Numerical simulation.

Iterated Entire Functions and Growth in Terms of Maximum Terms

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ABSTRACT

The maximum term of entire function is widely used by the researchers in the field of complex analysis. We have several results comparing the maximum terms of composition of two entire functions with the maximum terms of corresponding left and right factors. Also, the composition of entire functions can be extended into relative iteration of entire functions. In the paper, we consider the maximum term of iterated entire functions and compare the growth of them with their corresponding factors on the basis of slowly changing functions.

Keywords: Iterated entire function; Maximum term; Growth.

New Insights into Clunie's Lemma: Applications to Complex Differential Equations

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ABSTRACT

In this study, we explore refined variants of Clunie's fundamental lemma—originally stated in Clunie, J., *On integral and meromorphic functions*, *J. London Math. Soc.* 37 (1962), 17–27, MR 26 #1456—which have emerged through continued analysis and have significantly advanced the study of complex differential equations.

Keywords: Nevanlinna Theory; Clunie's Lemma; Meromorphic Functions; Complex Differential Equations.

Investigation on Electroosmosis Driven Trihybrid Couple Stress Blood Flow Within a Squeezing Artery: An Artificial Intelligence-Based Study

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ABSTRACT

Exploring electrokinetic phenomena in the context of biofluids blended with nanoparticles opens up possibilities for innovative biomedical applications. This research is centred on investigating streaming patterns in highly magnetized couple stress blood infused with single-walled carbon nanotubes (SWCNTs), titania, and alumina within a squeezing arterial channel influenced by electroosmosis. The model is designed with the imposition of an intense external magnetic field oriented perpendicularly to the channel, giving rise to phenomena such as Hall currents, ion-slip currents, and Joule heating. The electric potential within the electric double layer (EDL) is calculated through the solution of the Poisson-Boltzmann equation. Computation of the proposed blood flow model is accomplished by harnessing the Runge-Kutta-Fehlberg (RKF45) shooting scheme via the bvp4c solver in Mathematica. Notable outcomes include the observation that blood temperature regenerates with higher values of Hall and ion-slip parameters, while skin friction on the artery's upper wall abates as the electroosmosis parameter amplifies. An increase in nanoparticles' volume fraction (NVF) leads to higher Nusselt numbers on the upper wall. Furthermore, an artificial neural network (ANN) model is developed using reference datasets obtained from numerical outcomes. The findings of this study hold potential implications for the design of more effective drug delivery systems, biomedical devices, improved diagnostic accuracy and informed treatment decisions, among other applications.

Keywords: Couple stress trihybrid nano-blood; intense magnetic field; carbon nanotubes (CNTs); artificial neuron network (ANN).

Computational Intelligence Approach to Hemorheological Dynamics in Electrified and Magnetized Penta-Hybrid Nanofluid Media

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ABSTRACT

This research proposes a novel computational framework for modeling the predictive dynamics of blood transport through a highly magnetized penta-hybrid fluid within an endoscopic electrified ciliated arterial cavity. The model incorporates complex physical effects, including Hall and ion slip currents, cilia-induced motion, and electrical energy dissipation, to accurately capture the behavior of blood flow under physiological and electromagnetic influences. By applying lubrication approximations and Debye-Hückel linearization, the governing equations are simplified and analytically solved using the homotopy perturbation method. The analysis reveals that electroosmotic flow can either enhance or impede bloodstream velocity based on its orientation. Hall and ion slip currents contribute to flow synchronization, while extended cilia length promotes thermal regulation within the arterial channel. Additionally, increasing the Casson fluid parameter results in a significant reduction in blood temperature. An artificial neural network is employed to simulate and predict wall shear stress, achieving a remarkable accuracy of 99.98% in testing and 100% in validation. The outcomes of this study hold critical implications for the development of precise diagnostic tools and therapeutic strategies, including targeted antimicrobial delivery and optimized nanoparticle selection for infection management. This integrative approach bridges fluid dynamics, electromagnetism, and intelligent computing to advance medical modeling and clinical applications.

Keywords: Ciliated artery; penta-hybrid nano-blood; hall and ion slip currents; artificial neural network.

Exploring Electroosmotic Immiscible Blood Flow Incorporated with Hybrid Nanoparticles in Squeezed Arterial Channel

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ABSTRACT

This study investigates the immiscible blood flow in a squeezing artery, where the lower half contains Casson-type nano-blood and the upper half consists of Newtonian blood containing SWCNT and gold nanoparticles. The model reflects a realistic physiological scenario in which blood exhibits non-Newtonian behaviour due to suspended nanoparticles in certain arterial regions, while maintaining Newtonian characteristics elsewhere. The lower layer incorporates Casson rheology with nanoparticle effects to capture yield stress and microstructural influences, whereas the upper layer is modelled as a classical Newtonian fluid. The governing equations are solved using numerical approach to study velocity profiles, pressure distribution, and shear stress under various squeezing rates and physical parameters. Results reveal that the Casson nano-blood significantly alters flow resistance and wall shear stress compared to the Newtonian layer, particularly near the fluid interface. The presence of nanoparticles enhances the effective viscosity, contributing to flow control and potential biomedical applications in targeted drug delivery and microcirculation modelling. This work provides novel insights into asymmetric blood flow behaviour in arteries, emphasizing the need for multi-layered modelling in advanced biofluid research.

Keywords: Squeezing flow; Casson fluid; immiscible flow; nano-blood.

A Study on Electroosmosis Driven Trihybrid Non-Newtonian Blood Flow with Slip Conditions in A Ciliated Arterial Tube

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ABSTRACT

This study presents a comprehensive investigation into the electro-osmotic flow of gyrotactic microorganisms through a microchannel lined with cilia, where blood is modelled as a non-Newtonian Jeffrey fluid embedded with tri-hybrid nanoparticles. The model integrates several essential physical factors, including ciliary motion, heat generation, wall shear, chemical reactions, and thermal radiation, which are incorporated into the energy equation. Using lubrication theory, the complex fluid flow equations are simplified, and slip boundary conditions are applied to derive exact analytical solutions. The flow is driven by metachronal waves produced by the coordinated motion of cilia on the channel walls. A coordinate transformation shifts the analysis to a wave frame of reference, assuming long wavelength and low Reynolds number for further simplification. The research analyses vital flow parameters such as velocity profiles, pressure gradients, temperature changes, pressure rise, and streamlines. It reveals that fluid velocity increases with the Jeffrey fluid parameter but decreases with higher slip effects. Additionally, increasing the Brinkman number raises the fluid temperature, whereas thermal radiation has a cooling effect. The study also highlights the impact of extended cilia length on flow patterns within the annular region. These findings offer valuable insights for fields such as biomedical engineering, fluid dynamics, and diagnostic applications.

Keywords: Jeffrey fluid; trihybrid nanoparticles; slip conditions; thermal radiation.

Face-To-Face Collisions Take Place Between Solitary Wave Solutions of Two-Sided Nonlinear KP Solitons in Ion-Dust Acoustic Plasmas

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ABSTRACT

The face-to-face collision of nonlinear waves in dusty plasma with two temperature ions and a fluctuating dust charge is examined in this work. The reductive perturbation method was used to obtain the two-sided KP equation in a dusty plasma with two-temperature ions and variable dust charge. Phase shifts, trajectories, and soliton solutions are investigated using the expanded PLK approach. Phase shifts are examined in connection with temperature, charge, and dust particle density. We also investigated novel face-to-face collision solutions for various time assessments. Our results could help to clarify how DAW behaves in plasma conditions seen in space and in astrophysics where two-temperature ions are common.

Keywords: Face-to-face collision; Reductive Perturbation Method; KP equation; PLK technique.

Various Points on Several Alexandroff Spaces

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ABSTRACT

In the concept of kernels, open set, semi-open set, preopen set, b -open set and β -open set are not different. All of them induce the Alexandroff space. Dynamical system via ideal, filter and topological transitivity will be studied through this presentation. To do this, the various limit points of a dynamical system and its characterizations will be also a part of this study.

Keywords: Alexandroff space; Transitivity; Ideal; Filter.

Statistical Evaluation of Seasonal Foodgrain Production in West Bengal Across Kharif and Rabi Seasons Focusing on Gap-bridging Strategies

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ABSTRACT

The agrarian community in India largely operates within the conventions of agriculture that adheres to certain rhythms of seasonality. In terms of foodgrain production, the Kharif and Rabi cropping seasons are the two seasons most responsible for food and nutrition security. As part of the Indian food basket, West Bengal exhibits a clear seasonal divide in cultivation practices, yield outcomes, and productivity outcomes. This study presents a formal statistical examination of foodgrain production in 22 of the 23 existing districts in West Bengal, with comparisons made between the Kharif (monsoon) growing season and the Rabi (winter) growing season.

Using final estimates published by the government, the study focuses on three variables: area cultivated, yield per hectare, and total production. Descriptive statistics and paired sample t-tests were used to quantify the difference in area and productivity outputs. The results showed a statistically significant difference in area and total output produced, with Kharif area and output being far greater. Even though area planted to Rabi totalled a lesser amount, Rabi showed greater efficiency in yield on average.

These findings have wide-reaching implications. The combined reliance on Kharif agriculture has already added volatility to the food supply chain with growing monsoon variability with climate change. On the other hand, Rabi has significant yield potential and is used less than it could be. This paper advocates for policy to be reoriented towards reducing the seasonal gap with investments in irrigation, crop diversification, and local (district) planning. Growing the Rabi season is not only an economic requirement, but a climate adaptive approach for the future of Indian agriculture.

Prediction of Finite Population Proportion Using Bivariate Probit Model

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ABSTRACT

This paper proposes model-based predictive estimators for finite population proportions resulting from bivariate binary responses, incorporating information on auxiliary variables available for all units in the finite population. Due to the complexity of analytical expression for variance estimators, we suggest a computationally efficient hybrid bootstrap approach for variance estimation. The performance of the proposed estimator is evaluated through comprehensive simulation studies and compared with other commonly used design-based estimators. These findings are further supported by an empirical study using coal miners' data.

Keywords: Bivariate binary; auxiliary information; probit regression; predictive estimator.

Outlining The Impact of Electro-Osmotic Force and Mixed Convection Flow of EMHD Nanofluid Flow on the Stretched Cylinder: A Computational Layout

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ABSTRACT

This research has focused on studying the EMHD nanofluid flow over a stretched cylinder in the presence of electro-osmotic force and mixed convection. This inquiry shows a novel approach through the use of thermophoresis and Brownian motion and nanofluid is comprised of water and copper nanoparticles. Similarity transformations simplified the mathematical model and produced nonlinear ordinary differential equations with suitable boundary conditions, which the MAPLE-21 software numerically solved using the RK-4 shooting criteria. Tables and graphs have been used to illustrate the impact of the key flow factors on Electric potential profiles, velocity profiles, temperature outlines, and concentration distribution. Following the physical deliveries, we calculated the Sherwood number, Nusselt number, and skin friction. The electro-osmotic parameters increase, the electric potential profiles diminish, and a dual effect occurs for the curvature parameter. The Nusselt number declined for the electro-osmotic parameter and declined by 5.91% but the Sherwood number enhanced by 30.7% at a rate.

Keywords: Nanofluid; EMHD; Stretched cylinder; Electro-osmotic force; Mixed convection.

Mathematical Modelling to Cope with Deadly Diseases

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ABSTRACT

Mathematical modelling is an essential tool to ease our everyday life as well as to understand natural phenomena. Now-a-days Mathematical modelling is an integral part of medical sciences. Mathematical modelling plays a crucial role for understanding, diagnosing and treating many deadly diseases. This article will give insight to the diseases like cardio vascular diseases, cancer, epidemics like SARSE, MARSE, EBOLA, CORONA etc.

Modelling techniques gives us the proper planning and controlling measures of the diseases. Policy makers and researchers use Mathematical modelling to understand and predict the transmission of infectious diseases. In case of cardiovascular treatment to design and deploy coronary stents modelling plays a significant contribution. To predict tumor growth, metastasis in oncology and responses to therapy it plays an important role. Mathematical models help to analyze images to treat cardio vascular diseases, to detect and monitor treatment of tumors and to understand neurological disorders. Medical imaging is advancing through Mathematical modelling. In modelling computer simulations are performed to validate the applicability of the models in each field of medical sciences.

Keywords: Mathematical model; cardiovascular diseases; epidemic; cancer.

Delta-Compactness: A Generalization of Compactness in Topology

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ABSTRACT

The aim of this paper is to introduce the concept of delta-compact spaces, which serves as a generalization of traditional compactness in topology. We begin by presenting a formal definition of delta-compact spaces and explore several basic properties that distinguish them from other known compact-like spaces such as compact, locally compact etc. Through illustrative examples, we demonstrate how delta-compactness behaves under various topological constructions.

A central focus of this study is to examine the behaviour of delta-compact spaces under continuous mappings. We investigate whether delta-compactness is preserved under continuous images and determine sufficient conditions for such preservation. This analysis reveals how delta-compactness interacts with continuous functions and further clarifies its role within topological theory.

In the final section, we introduce the notion of locally delta-compact spaces. It is further observed and established that every closed subspace of a locally delta-compact T_3 space is also locally delta-compact.

Keywords: Delta compact set; delta closed mapping; locally delta compact set.

Inverse Eigenvalue Problem Using Partially Prescribed Eigendata for the Symmetric Tridiagonal Matrix Polynomial

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ABSTRACT

This study concentrates on the inverse eigenvalue problem (IEP) associated with a symmetric tridiagonal quadratic matrix polynomial. Essentially, the goal of this problem is to determine the symmetric tridiagonal matrices $K \epsilon R^{n \times n}$ and $C \epsilon R^{n \times n}$ based on prescribed m (where $1 \leq m \leq 2n$) eigenpairs so that the corresponding quadratic matrix polynomial $P(\lambda) = \lambda^2 I + \lambda C + K$ has the given eigenpairs as its eigenvalues and eigenvectors. This paper provides a necessary and sufficient condition for the existence of a solution to this problem. Furthermore, analytical formulas for solutions K and C are offered using matrix vectorisation**.** A notable advantage of the proposed method is that it does not limit the number of eigenpairs required for a solution to exist. The effectiveness and accuracy of the method are demonstrated through various numerical examples.

Keywords: Quadratic matrix polynomial; inverse eigenvalue problem; symmetric tridiagonal matrix.

Wind-Influenced Transport of a Reactive Solute through a Laminar Channel with a Porous Layered Bed

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ABSTRACT

The transport of solute in a laminar open channel flow through and over a porous layered bed surface holds great importance in natural water resources such as rivers, wetlands, and coastal zones. Such kind of research is made more realistic when the influence of wind, both along and opposite to the direction of flow, is considered at the open surface of the water bodies. The transport phenomena of tracer molecules in a two-layered channel flow, where the lower one is occupied by a porous medium, is analyzed under the influence of wind blowing over the upper surface. The present analytical study provides the exchange, advection, and dispersion coefficients, which are valid across all time scales by employing Sankarasubhramanian & Gill's generalized dispersion approach. Findings illustrate that wind direction critically regulates the transport process: wind-aligned flow amplifies advection-driven dispersion, and opposing wind suppresses solute spreading and promotes localized retention. Furthermore, an elevated absorption parameter steepens the vertical gradient and confines the solute within the upper region as it rapidly moves with the wind. The insights from this research could help to address water pollution in rivers where the flow field is highly influenced by airflow.

Keywords: Wind driven flow; Solute transport; Dispersion; Boundary absorption.

Noetherian Pseudo-Prime Spectrum of a Topological Le-Module

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ABSTRACT

An le-module M over a commutative ring R is a complete lattice ordered additive monoid $(M, \leq, +)$ having the greatest element e together with a module like action of R. This article characterizes the le-modules ${}_RM$ such that the pseudo-prime spectrum X_M endowed with the Zariski topology is a Noetherian topological space. If the ring R is Noetherian and the pseudo-prime radical of every submodule element of ${}_RM$ coincides with its Zariski radical, then X_M is a Noetherian topological space. Also, we prove that if R is Noetherian and for every submodule element n of M there is an ideal I of R such that V (n) = V (Ie) then the topological space X_M is Noetherian.

Keywords: Pseudo-prime submodule element; Zariski topology; Topological le-module; Noetherian space.

Hydromagnetic Oscillatory Instability in Non-Linear Thermohaline Convection of Chemically Reactive Casson Fluid Through a Porous Layer: Effect of Open Boundary

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ABSTRACT

This work investigates oscillatory instability in non-linear thermohaline convection of Casson fluid flow through a porous medium open at the top. The problem uses a non-linear Oberbeck-Boussinesq approximation to describe how fluid density changes. It also includes heating due to viscous dissipation under an externally imposed vertical magnetic field, accompanied by a first-order chemical reaction. The flow field is non-dimensionalized with the help of the proper choice of scales, while the base flow is then perturbed with a small fluctuation to examine instability theory. The Runge-Kutta method, combined with the shooting technique, is employed for the numerical integration of eigenvalue problems that arise from stability analyses. The graphical illustration is made for critical thermal Rayleigh numbers concerning each flow-governing parameter, and quantitative values in tabular form are provided. Our results reveal that the non-linear solutal effect γ_{2} acts to stabilize the solute distribution over the two walls when the lower wall has a higher concentration of solute than the upper wall ($Ra_{S}<0$). Under zero solute transport conditions ($Ra_{s}=0$), however, γ_2 is linear. Of note is the fact that the stabilized γ_{2} has become destabilized because of the large amount of solute at the upper wall relative to that at the lower ($Ra_{S}>0$). Still, in every case, the non-linear thermal effect γ_{1} acts to destabilize.

Keywords: MHD instability; Thermohaline convection; Non-linear Boussinesq approximation; Open upper top.

Some New Congruences for 2-Regular Partition with Designated Summands

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ABSTRACT

In 2002, Andrews, Lewis and Lovejoy introduced and studies the partition function which they called *partition with designated summands,* denoted by $PD(n)$. $PD(n)$ are constructed by taking ordinary partitions and tagging exactly one of each occurrence of a part. In this seminar some congruences for $PD_k(n)$, the number of k-regular partition with designated summands for different values of k will be discussed. The generating function of $PD_k(n)$ is defined as follows

$$\sum_{n=0}^{\infty} PD_k(n)q^n = \frac{(q^6;q^6)_\infty (q^k;q^k)_\infty (q^{2k};q^{2k})_\infty (q^{3k};q^{3k})_\infty}{(q;q)_\infty (q^2;q^2)_\infty (q^3;q^3)_\infty (q^{6k};q^{6k})_\infty}$$

Where $(a;q)_\infty = \prod_{n\geq 0}(1-aq^n)$, represents the q −series or q −Pochhammer symbol. Some new infinite family of congruence for $PD_k(n)$ will be explored.

Keywords: Partition function; Regular partition; Dissections; Congruence.

On The Angle Criteria for Frame Sequences in Separable Hilbert Spaces

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ABSTRACT

In this paper, we study the condition that the union of frame sequences is also a frame sequence in a separable Hilbert space. We also study the angle between subspaces of a separable Hilbert space.

Keywords: Angle; Frame; Separable Hilbert space.

Construction of Non-Regular Cospectral Graphs

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ABSTRACT

Spectral graph theory investigates the interplay between the structure of a graph and the spectra of associated matrices such as the adjacency matrix and the Laplacian matrix. This presentation explores constructions of non-regular graphs that are simultaneously cospectral with respect to both matrices. We take a graph operation involving subdivision and the Q-graph to generate such examples. Emphasis is placed on recent developments that provide systematic methods for generating such graphs. These constructions contribute to a deeper understanding of spectral characterizations of graphs.

Keywords: Spectral Graph Theory, Cospectral Graphs, Subdivision Graphs, Q-graph, Non-regular Graphs.

Mathematics Attitude of Secondary School Students in relation to Problem Solving Ability

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ABSTRACT

The impact of secondary school student's concepts, emotions, and attitudes toward mathematics on their problem-solving skills is evident through various assessments. A student's attitude includes interest in mathematics, curiosity, confidence in problem-solving and perceptions of the relevance and usefulness of mathematics in everyday life. Mostly, students with positive attitudes toward mathematics are more confident, motivated, and successful in solving mathematical problems. On the other hand, students with negative attitudes may experience anxiety, monotony, or fear, which can hinder their problem-solving abilities and barrier overall development. Properly exploring this relationship can help teachers and schools find more effective approaches to support students, increase their interest in mathematics and increase their overall academic success, and can also include co-curricular activities such as mathematics clubs, mathematics laboratories, mathematics - organized quiz programs, puzzles, riddles, magic and games for developing skills in solving puzzles and using mathematics as a game for recreation. Mathematics attitude is not just a personal feeling. It directly affects student's mathematical thinking, creativity and problem-solving abilities. Understanding this relationship can help teachers design better teaching strategies, teaching methods, reduce mathematics anxiety and improve student outcomes in mathematics.

Keywords: Mathematics attitude, Academic success, Co-curricular activities, Creativity, Problem-solving abilities.

In Non-Equilibrium Thermodynamic Prescription Cold Inflation with Dissipation Mechanics imply Warm Inflation

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ABSTRACT

The present work is an attempt to find inter relationship between the cold and warm inflationary scenarios. Here cold inflation is described by a single scalar field (inflation) and non-equilibrium thermodynamical prescription is imposed. It is found that this quasi-de-Sitter phase of evolution is equivalent to warm inflation. The present work also addresses the question whether the dissipation is Hawking-type or not.

Keywords: Cold Inflation; Warm Inflation.

A Computer Network's E-Virus Parameter Estimation and Prediction: An Illustration Using Covid-19 Epidimilogical Data

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ABSTRACT

We proposed a compartmental e-epidemic model of SEIRI (Susceptible–Exposed–Infected–Recovered–Infected) under COVID -19 epidemiological data to understand the attacking behaviour of computer viruses in a computer network because they have the same nature as biological viruses in populations. We assumed that once a computer virus entered a network, it would become susceptible and spread throughout the network in accordance with the model. The R_0 has been computed to quantify the computer virus's ability to spread throughout the network. Using the fundamental reproduction number, the model's stability has been computed at the equilibrium locations. Studies have shown that the model is unstable if $R_0>1$ and stable at the disease-free equilibrium points if $R_0<1$. A proposed model's validity has been established using COVID-19 observational data from India's first wave. Using the COVID-19 instance, the nonlinear regression method was applied to forecast future infection rates. To estimate the model's parameters from observed data, the minimize nonlinear least squares approach has been employed.

Keywords: SEIRI Model; Basic reproduction number; Stability analysis; Curve fitting; Model parameters.

A Modified Gravity Theory as a Dark Energy Model

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ABSTRACT

Dark energy, characterized by a huge negative pressure, has become a topic of paramount importance in the field of cosmology. It is considered responsible for the late time expansion of the universe at an accelerated rate. A spherically symmetric space-time in 5D is investigated within the framework of Scale Covariant Theory. The model turns out to be a phantom dark energy dominated isotropic model. The model tends to the de-Sitter phase in the future avoiding the finite time big rip singularity. The variation of gravitational constant G is estimated to be -7.2×10^{-11} yr^{-1} whereas that of Hubble's parameter is obtained as $H_0 = 68$, aligning with $H_0 = 67.4 \pm 0.5$ $kms^{-1}Mpc^{-1}$ of the latest Planck 2018 result.

Keywords: Dark energy; spherically symmetric; higher dimension; Scale Covariant Theory.

Some Notes on Weakly Nil Clean Rings

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ABSTRACT

Nil clean rings and weakly nil clean rings have been studied by several authors. In this paper we consider some aspects of indecomposable noncommutative weakly nil clean rings. We obtain some results and exhibit that these results extensively differ with commutative indecomposable weakly nil clean rings.

Keywords: clean rings, nil clean rings, weakly nil clean rings.

A Study on the Validity of Thermodynamic Laws in $f(P)$ Gravity

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ABSTRACT

In this work, we shall analyse the validity of the Generalized Second Law of Thermodynamics (GSLT) and Thermodynamic Equilibrium (TE) within f(P) gravity, where $P = R_{\mu\nu}R^{\mu\nu}$. Considering the model $f(P) = P + \alpha P^n$, we study entropy evolution on both apparent and event horizons using a ΛCDM background. Expressing all quantities in terms of redshift z, we verify the conditions GSLT and TE. The results show that for suitable parameters, both laws hold, supporting f(P) gravity as a viable framework for cosmic acceleration.

Keywords: f(P) gravity; Generalized Second Law of Thermodynamics; Thermodynamic Equilibrium; Horizon (Apparent & Event).

Influence of Maturation Delay and Fear on Age-Selective Harvesting in Prey-Predator Interactions

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ABSTRACT

Economically beneficial fisheries are crucial for both food security and economic prosperity of fishing communities. In this aspect, age-selective harvesting strategies have been widely used for sustainable profit generation by focussing on individuals above a specific age or body size. Hence, we proposed and analyzed the impact of age-selective nonlinear harvesting and predator-induced fear on the dynamics and bio-economics of a Hassell-Varley type prey-predator model in which the growth of the prey population is of Richards' type. Existence and local stability criterion of the model's equilibria along with bionomic equilibrium are obtained, highlighting the dependence of the coexistence equilibrium on both maturation delay and harvesting effort. An absence of maximum sustainable yield (MSY) policy is noted, despite the positive correlation of total yield and harvesting effort. Moreover, it is shown that an accurate age-selection of prey is necessary for generating profit from this type of harvesting strategy. Sensitivity analysis further reveals that the net revenue from harvesting is dependent on various parameters such as maturation delay and harvesting effort. Numerical simulations are obtained using MATLAB for validation of the analytical results, which highlight the importance of implementing an efficient harvesting policy aimed at avoiding excessive harvesting. Hence, our proposed model leads to more generalized age-selective harvesting strategy by incorporation of Richards' type growth in prey.

Keywords: Hassell-Varley type functional response; Age-selective harvesting; Bionomic equilibrium; Maximum sustainable yield.

An HIV/AIDS Epidemic Model with Non-linear Saturated Incidence Rate and Treatment

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ABSTRACT

In this paper I have proposed an HIV/AIDS epidemic model with non-linear saturated incidence rate and treatment. The model approves for some infected individuals to move from the symptomatic phase to the asymptomatic phase by all manners of treat- ment methods. First, formulate the model and find its basic reproduction number. Mathematical analyses establish that the global dynamics of the spread of the HIV infectious disease are completely determined by the basic reproduction number R_0. For the basic reproduction number $R_0 < 1$, the disease-free equilibrium is stable locally as well as globally. Whether $R_0 > 1$, the endemic equilibrium point is stable locally. Finally; found the numerical solution of the model which justify the analytical results.

Keywords: HIV/AIDS Epidemic model; Non-linear incidence; Basic reproduction number; stability; Treatment; Numerical results.

Mathematical Science as an Integrated Approach in Solving Global Challenges

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ABSTRACT

Mathematical science has become increasingly vital in addressing global challenges such as climate change, pandemics, economic crises, and sustainability issues. This paper explores how the integration of mathematical modeling, computational tools, and analytical reasoning supports effective solutions to complex problems. The objective is to examine how mathematics contributes to evidence-based decision-making, enhances predictive capabilities, and fosters interdisciplinary approaches for global problem-solving. A mixed-method research design was adopted, combining case studies from public health, environmental science, and disaster management with simulations and expert interviews. The findings demonstrate that mathematical techniques—such as optimization, network analysis, and statistical forecasting—play a key role in formulating efficient and scalable strategies. For example, epidemiological models have been instrumental in managing the spread of infectious diseases, while resource allocation models support sustainability goals. Moreover, the study emphasizes that collaboration between mathematics and other disciplines improves problem comprehension and solution design, leading to more resilient systems. Mathematical science provides a universal framework that links data, policy, and innovation, enabling a systematic approach to challenges that are global in nature and require coordinated responses.

In conclusion, the integration of mathematical science with other domains empowers societies to navigate uncertainty and develop long-term, sustainable development strategies. Future efforts should focus on making these tools more accessible and encouraging cross-sectoral partnerships for impactful global action.

Keywords: Mathematical Modeling, Interdisciplinary Approach, Sustainable Development, Global Challenges

Universality Of Limiting Values of Inequality for Socio-Economic Issues

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ABSTRACT

Socioeconomic phenomena and inequality are inseparable issues. In general inequality is measured with the help of Gini Index. Theoretically it lies between 0 and 1. If the system is perfectly unequal state, then corresponding Gini index is 1 and if it lies in perfect equality then corresponding value of Gini index is 0. In general, Gini index lies between these two extremities. However, while analyzing temporal variation of inequality in state-wise infection rate of COVID-19 in India, I have found that Gini index lies between different extremities apart from 0 and 1. In general it shows maxima around 0.86-0.88. The same result is obtained if we consider inequality in stste-wise death cases due to COVID-19 in India. Various other types of socio-economic research done in the literature and which are not interconnected reflect the same maxima. So, it can be demanded that 0.87 is a universal maxima of Gini Index for any type of realistic social issues.

Keywords: Inequality; Gini Index; Socio-economic issues; maximum value; universality.

On Common Fixed Points of Generalized α −nonexpansive Multivalued Mappings

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ABSTRACT

In this study, we introduce a new class of multivalued mappings, called generalized α-nonexpansive mappings. We examine the topological structure of their fixed point sets and investigate the conditions under which such mappings exhibit fixed point behavior. Furthermore, we establish existence results for common fixed points of a pair of mappings—one single-valued and one multivalued—both satisfying the generalized α-nonexpansiveness condition. These results extend and unify several known fixed point theorems in nonlinear analysis

Keywords: Common fixed points; Multivalued mappings; Nonexpansive mapping.

Thermo-Radiative Slip Flow of Ag/TiO_2 Nanoparticles in a Hybrid $C_2H_6O_2$–H_2O Base Fluid: A Solar Energy-Driven Analysis

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ABSTRACT

Nanofluids are of significant interest due to their enhanced heat transfer capabilities, with diverse applications in solar energy collectors, microwave absorbers, thermal management of electronic devices, cooling systems, biomedical engineering, and heat exchangers. This study examines the unsteady two-dimensional mixed convective boundary layer flow of a hybrid nanofluid composed of Ag/TiO_2 nanoparticles suspended in a 50:50 ethylene glycol–water ($C_2H_6O_2$–H_2O) base fluid, subject to solar radiative heating and a variable magnetic field. The model incorporates surface velocity slip and thermal jump conditions. Governing partial differential equations are reduced to a system of nonlinear ordinary differential equations using similarity transformations and solved numerically via the Runge-Kutta-Fehlberg method under suitable boundary conditions. The effects of key parameters—magnetic field strength, thermal radiation, temperature ratio, and thermal slip—are analyzed on the velocity and temperature profiles. Results reveal that temperature rises with increasing magnetic, radiation, and thermal slip parameters, while the velocity slip parameter exhibits a cooling effect. Notably, TiO_2-based hybrid nanofluids demonstrate superior thermal transport compared to Ag-based counterparts under magneto-radiative conditions.

Physical Sciences

Molecular Insights into CO_2 Adsorption Mechanisms in Metal-Organic Framework HKUST-1(Cu-BTC)

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ABSTRACT

Global concern over the environmental hazard created by CO_2 emissions has grown significantly. Scientists are interested in porous adsorption employing metal-organic frameworks (MOFs) because of its enormous potential for CO_2 adsorption applications. Inapplications like post-combustionCO_2capture, effectiveCO_2 capture in humid conditions is a significant problem for metal-organicframeworks (MOFs). Molecular dynamics (MD) and Grand Canonical Monte Carlo (GCMC) simulations have been used to analyze the effect of CO_2 adsorption in HKUST-1, a copper-based MOF (Cu-BTC). Though HKUST-1 has good CO_2 uptake capability in dry conditions but the adsorption mechanism in humid conditions is still not well understood computationally. We simulate CO_2 uptake and diffusion kinetics under dry and humid conditions at 273–313 K and 0.1–30 bar, using Universal ForceField (UFF)/Trappe force fields and Qeq charges in Large-scale Atomic/Molecular Massively Parallel Simulator (LAMMPS) and RASPA. Radial distribution functions (RDFs) have been computed to probe CO_2/H_2O-Cu^{2+} interactions. We expect water coordination to reduce CO_2 uptake and slow diffusion, offering insights into adsorption mechanisms. This work guides the design of robust MOFs for industrial CO_2 capture in realistic humid environments.

Keywords: Adsorption; GCMC/MD simulation; Cu-BTC; CO_2 capture.

Audio Encryption and Decryption Using Double Random Phase Encoding Technique

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ABSTRACT

A novel approach is proposed for secure audio encryption using the Double Random Phase Encoding (DRPE) technique, traditionally employed in optical image security. This work presents a framework to convert real-valued 1D audio signals into 2D complex-valued spectrogram representations using Short-Time Fourier Transform (STFT), making them suitable for DRPE-based encryption. Two statistically independent random phase masks are used—one in the spatial domain and another in the Fourier domain—to generate encrypted data using a 2D complex Fourier domain scrambling operation. The resulting encrypted complex-valued signal can be stored or transmitted securely, with robustness against signal tampering ensured by the inherent sensitivity of DRPE to phase distortions. For decryption, the conjugate of the same pair of phase masks is used to recover the complex spectrogram, which is then inverted via Inverse STFT to reconstruct the original audio signal. Experimental simulations on real-world audio data confirm the effectiveness and accuracy of the proposed scheme. This technique provides a new direction for the optical encryption community to extend their framework into the domain of secure audio communication, biometric voice protection, and covert signal transmission.

Keywords: Optical encryption; double random phase encryption; audio cyphertext; digital cryptography.

Impact of Direct and Indirect Coupling-delay in Coupled Oscillators

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ABSTRACT

We investigate the emergent dynamics of coupled oscillators arising from the interplay between diffusive and environmental coupling in the presence of time delays. Our study reveals that, in contrast to environmental coupling delays—which tend to revive oscillations—the propagation delay in the diffusive path leads to the emergence of *death islands*, encompassing both amplitude death (AD) and its revival. We demonstrate that the combined presence of both types of propagation delays not only supports the suppression and revival of oscillations but also enables multiple transitions between AD states and synchronized states. Notably, the revival from AD exhibits distinct synchronization characteristics: when induced by diffusive coupling delay, the system exhibits out-of-phase synchronized oscillations, whereas revival via environmental coupling delay results in in-phase synchronization. These transitions are governed by the interplay of time delays and coupling strengths. We explore these complex behaviors using a combination of theoretical approaches and numerical simulations. To validate our findings, we perform a linear stability analysis and support the theoretical predictions through electronic circuit-level experiments. Our results will be helpful for better understanding of time-delay-induced control in the dynamics of coupled oscillators.

Keywords: Amplitude death; propagation delay; revival of oscillations; synchronization.

Analytical Exercise of Flat Band Physics

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ABSTRACT

The specific topological character of the lattice has a strong influence on the eigenspectrum and in certain cases it can induce exotic spectral features through a set of macroscopically degenerate dispersionless flat bands. Low-dimensional networks within the tight-binding formalism provide ample example for that and they have received considerable attention in diverse topics of condensed matter physics over the past few years. An interesting point about the flat band is that the dispersion curve is essentially flat in curvature in the sense that the single particle energy is independent of the momentum of the particle. This brings a concept of divergent effective mass and zero mobility. The physical reason behind the overall transmission corresponding to flat band mode across a full lattice being practically zero is the local geometric phase cancellation at the connector nodes. This means that the "energy" is trapped as a direct consequence of destructive quantum interference. Here we have discussed some relevant analytical pathway to discern the "compact localization" of single particle eigenstates leading to momentum insensitive flat bands for different quasi-one-dimensional networks.

Keywords: Flat band; tight-binding; quantum interference; compact localization.

A DFT and Kinetic Monte-Carlo Overview on H_2 Storage over Hexagonal ZnO Monolayer

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ABSTRACT

Zinc oxide (ZnO) monolayer has a structure analogous to graphene, but with an alternate arrangement of Zn and O atoms. With a large surface area and chemical stability, it can be used for the storage and sensing of H_2 molecules, which is considered as a green energy fuel. The adsorption energy of H_2 molecules over different sites of the ZnO monolayer has been calculated using van der Waals density functional theory (vdW-DFT). The repulsive interaction existing between two H_2 molecules limits the maximum number of H_2 adsorption to one, above the O atom per ZnO unit cell. Using the results from the vdW-DFT calculations, a kinetic Monte-Carlo code has been run to study the adsorption, desorption, diffusion dynamics along with the overall surface coverage of the H_2 molecules over the ZnO surface at different temperature and pressure. The kMC code predicts that the surface coverage is high at 5.0 atmospheric pressure and below 200 K. Further, the adsorption energy increases significantly for Zn-vacancy in a defect induced ZnO system which can be beneficial for practical applications. Also, the H_2 adsorption energy does not change for increasing the ZnO layer number (from monolayer to bilayer, trilayer) and primarily depends on the surface atoms.

Keywords: ZnO monolayer; H_2 storage; density functional theory; kinetic Monte-Carlo.

The Interplay of Attraction and Repulsion in Coupled Quantum Oscillators

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ABSTRACT

The collective behaviors exhibited by coupled oscillators capture significant interest across the fields of physics, chemistry, and biology. This paper explores the dynamics of quantum Stuart-Landau oscillators influenced by simultaneous attraction and repulsion in the coupling path. We observe an intriguing transition from quantum limit cycle oscillation to a quantum inhomogeneous steady state. This transition presents a departure from the previously established understanding of the symmetry-breaking transition, which involves a shift from a quantum homogeneous state to an inhomogeneous steady state. The analysis of the noisy classical model also supports the results in the weak quantum regime. We show that the symmetry-breaking scenario also holds good in the deep quantum regime. We observe entanglement generation linked to a symmetry-breaking transition, without a classical equivalence. This study provides valuable insights into the collective behaviors of coupled oscillators in the quantum domain, contributing to a deeper understanding of this complex phenomenon.

Keywords: Symmetry-breaking; Lindblad master equation; entanglement; collective behaviors.

Two-Dimensional Be_2C_2-Type Materials: Structural Analogues of Graphene with Dirac Cone Electronic Properties.

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ABSTRACT

The emergence of two-dimensional (2D) materials, particularly those with hexagonal symmetry that give rise to peculiar electrical phenomena such as Dirac cones, has caused a significant change in condensed matter physics. Among these, Be_3C_2 and related Be_2C_2-type compounds are showing promise as metal–carbon materials. They have new bonding properties and tunable electrical features, similar to the honeycomb lattice of graphene. In this review, 2D materials with structures like Be_2C_2 monolayers are examined, with particular attention paid to their massless Dirac fermions, sp^2-like bonding, and hexagonal frameworks.We analyze how light elements like Be, B, C, and N contribute to the maintenance of planarity and electronic symmetry in systems like Be_3C_2, B_2C, BC_3, C_3N, BeN, and g-B_3N_3C. Researchers have demonstrated that these materials have strong Dirac cones, high Fermi velocities, and exceptional stability—even under mechanical strain or spin–orbit interactions—using techniques such as density functional theory (DFT), particle swarm optimization (PSO), and tight-binding models. The goal of this paper is to stimulate more research into lightweight, flexible, and high-performance 2D semimetals by outlining the landscape of Be_2C_2-type and related materials. These discoveries could open the door to new experimental developments and incorporation into electronic and quantum technologies of the future.

Keywords: Two-dimensional materials; dirac cone; Be–C compounds; hexagonal symmetry.

Unraveling Mechanical and Electronic Attributes of MN_4 (M= Be, Mg, Zn, Cd) Monolayers and their Excellent Supercapacitive Performances

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ABSTRACT

The recent experimental realization of the BeN_4 monolayer, known as beryllonitrene (Phys. Rev. Lett. 126 (2021), 175501), has introduced a novel family of nitrogen-rich two-dimensional materials, designated as MN_4 (M = Be, Mg, Zn, Cd). In this study, we employ first-principles calculations to investigate their anisotropic mechanical and electronic properties systematically. Electronic band structure analysis reveals that all the MN_4 monolayers host anisotropic Dirac cone-like features. To elucidate the origin and stability of these Dirac cones, we propose a simple coupled-chain model that effectively supports our numerical findings. Furthermore, we explore the capacitive responses of these materials by calculating their quantum capacitance over different electrochemical potential ranges. Notably, CdN_4 shows the highest quantum capacitance, reaching 219 μF/cm² at positive electrode potentials. The suitability of each material as a cathode or anode is further assessed by evaluating the surface charge density (Q_a and Qc). Specifically, MN_4 analogues exhibit almost equal anodic and cathodic charge densities, rendering them promising for symmetric supercapacitor applications. Moreover, a substantial enhancement in quantum capacitance is observed for BeN_4 upon metal atom adsorption, particularly at positive electrode potentials. These insights are expected to stimulate future research toward the design of advanced nanoelectronics and energy storage devices based on these emerging class of nitrogen-rich 2D materials.

Keywords: Dirac cone; quantum capacitance; surface charge density.

Study of Excited-State Intramolecular Proton Transfer in 8-Hydroxyquinoline and Its Derivatives at Different Positions

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ABSTRACT

This study examines how different substituents—specifically OCH_3 and CF_3 groups placed in various positions—affect the excited-state intramolecular proton transfer (ESIPT) in 8-hydroxyquinoline (8HQ) derivatives. Using density functional theory (DFT) and time-dependent DFT (TD-DFT) at the B3LYP/6-311++G(d,p) level, we calculated vertical excitation energies, ESIPT barriers, and emission energies. Potential energy curves (PECs) along the proton transfer coordinate were constructed to visualize the ESIPT process, and Quantum Theory of Atoms in Molecules (QTAIM) analyses identified key hydrogen-bonding interactions. Our results show that electron-donating groups like OCH_3 at position 2 increase the ESIPT barrier by stabilizing the enol form, while electron-withdrawing CF_3 groups at positions 5 and 7 decrease the barrier by enhancing proton acidity. The PECs favor the keto tautomer in the excited state, with barrier heights influenced by the type and location of the substituents. Additionally, QTAIM parameters—such as electron density and its Laplacian at hydrogen bond critical points—strongly correlate with ESIPT barriers, providing deeper insight into the electronic factors at play. Overall, these findings suggest that the photophysical properties of 8HQ derivatives can be tuned through specific molecular modifications. Such insights are valuable for designing advanced materials for fluorescence sensing, organic light-emitting diodes (OLEDs), and bioimaging.

Keywords: 8-Hydroxyquinoline derivatives; density functional theory (DFT); excited-state intramolecular proton transfer (ESIPT); organic light-emitting diodes (OLEDs).

Photonic Crystal: Next-Generation High-Speed Optical Switch

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ABSTRACT

The demand for faster data transmission with lower latency and higher bandwidth through our communication systems has led to the rapid development of optical switching technologies. The utilization of designed bandgaps that can be used to alter the propagation of light gives photonic crystals (PhCs) great potential for use in developing next-generation optical switches that will exceed the speed and efficiency of their electronic counterparts. This article summarizes recent developments in optical switches utilizing photonic crystals, and reviews the important design concepts, materials related to, and fabrication methods for some PhC-based optical switches. Here, the desired switching mechanisms for ultrafast switching with photonic crystals include resonant cavity tuning, nonlinear optical effects, dynamic path alteration and different modern electronic components. Here, recent advances in 2D photonic crystals for compact, energy-efficient, scalable optical switches are also focused. The paper also concludes with the contribution of valuable aspects of photonic crystals and their role in creating different types of fast, low-power optical switches. In the future, this high-speed optical switching can be successfully applied in wide-ranging applications from data centres, quantum communication, and optical networks.

Keywords: Photonic crystals (PhCs); optical switching operation; quantum computing; high-speed information processing.

Abhaya Safety Necklace: Development and Application of a Multifunctional Prototype for the Self-help of Women at Adverse Situation

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ABSTRACT

Women continue to struggle for their rights in the modern world, even after Independence. They still face exploitation, sexual assault, acid attacks, and sex-selective abortions, among other challenges. Ensuring women's safety is essential whether at home, in public, or at the workplace. Recent incidents, especially cases of rape, have generated widespread fear and distress. There is a clear need for intelligent safety devices to help women protect themselves from societal threats and overcome these obstacles. Traditional systems have limitations: they rely on applications that often lack effective self-defence mechanisms and are not suitable for carrying outside. This paper primarily focuses on improving women's safety through location tracking and self-defence solutions by using the women safety necklace (Abhaya). This prototype is equipped with a GPS signal tracker that operates independently of a mobile phone and features a built-in sharp blade, coated with an irritant chemical, concealed within the necklace for immediate protection in emergencies. By monitoring the victim's live location, the system automatically confirms the correct position to parents or designated caregivers.

Keywords: Women safety; safety necklace, GPS signal tracker.

Controlled Electro-Osmotic Flow in Microfluidics: A Brief Review

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ABSTRACT

This review outlines the principles and applications of electrokinetic flow in microfluidics, with emphasis on electro-osmotic flow (EOF) as a reliable, non-mechanical method for fluid transport. EOF arises from electric field interactions with the electric double layer (EDL) near charged microchannel walls, resulting in plug-like velocity profiles. The governing equations—Poisson–Boltzmann, Laplace, and Navier–Stokes—jointly describe the electrostatic potential, flow field, and transport dynamics. Electrokinetic systems support miniaturized, portable lab-on-a-chip devices and enable precise, programmable flow control without moving parts. Strategies for spatial and temporal modulation include patterned zeta potentials and redox-active surfaces. The review discusses electrokinetic convection-enhanced delivery as an alternative to pressure-based infusion for brain-targeted therapies, and highlights how surface slip, geometry, and surface engineering control EOF performance.

Keywords: Electro osmotic flow; electric double layer; EOF control; zeta potential.

Mass Bimodality and Orbital Dynamics in Hot Jupiters: Evidence for Divergent Formation Pathways

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ABSTRACT

Hot Jupiters remain an enigmatic class of exoplanets due to their extreme proximity to host stars and atypical physical characteristics. In this study, we critically analyze a sample of over 300 hot Jupiters—constituting the largest statistical set of its kind—to investigate correlations between planetary mass, and orbital eccentricity. These parameters were examined with attention to detection bias, particularly the limitations and preferences of the transit and radial velocity methods. Results reveal a statistically significant bimodal distribution in planetary masses, with a pronounced discontinuity near 4 Jupiter masses, implying the potential existence of two dynamically distinct subpopulations. Furthermore, a consistent correlation between higher mass and moderate eccentricity (mean e = 0.050 ± 0.008) challenges the assumption that tidal circularization uniformly dominates close-in giant planet evolution. Instead, the data support a scenario where eccentricity excitation—possibly through high-eccentricity migration or dynamical interactions—persists in more massive systems. These findings suggest that current models of hot Jupiter formation and migration may oversimplify the diversity within this population, and that multiple formation channels, including disk migration and dynamical scattering, likely coexist. This study calls for a re-evaluation of hot Jupiter classification schemes and emphasizes the need for more nuanced theoretical models.

Keywords: Hot Jupiter; exoplanet; eccentricity; planetary migration.

Viscous Gauss-Bonnet Gravity & Its Bouncing Features

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ABSTRACT

In our article, we consider the modified gravity theory named as Viscous Gauss-Bonnet Gravity where the Gauss-Bonnet gravity is equipped with viscous fluid. Again, the bouncing cosmology can avoid the long standing singularity problem in the context of cosmology. Hence, we have analyzed the bouncing characteristics of the above stated modified gravity theory. For that we have considered the different scale factors of the universe such as matter bounce, super bounce, symmetric bounce, oscillatory bounce and exponential bounce taking different bouncing parameters. Again, we have also taken the form of the Gauss-Bonnet function f(R, B) as power law of the parameters R and B and the pressure of the dominating viscous fluid is taken as $p_v = - 3\eta H$, where H is the Hubble parameter and η is viscous parameter taking positive value. For stability analysis we use the cosmic parameter square speed of sound and also we have checked the three energy conditions: null energy condition, weak energy condition and strong energy condition.

Keywords: Viscous Gauss-Bonnet gravity; bouncing cosmology; cosmic parameter; energy condition.

Exploring the Structure and Stability of Compact Star in Modified F(Q) Gravity Framework

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ABSTRACT

The current work is intended to examine the structure and stability of compact stellar objects within the framework of f(Q) gravity, which is a modified gravity theory where gravitational interactions emerge from nonmetricity rather than curvature or torsion. This formulation preserves second-order field equations while introducing a richer geometric description of ultra-dense astrophysical environments. By assuming a linear form of the function $f(Q) = \alpha Q + \beta$, we derive modified field equations for static, spherically symmetric anisotropic fluid distributions, ensuring regularity through the Krori-Barua metric. Our approach is applied to model compact stars—LMC X-4, SMC X-4, Cen X-3, and Vela X-1—using realistic values for central density and pressure. It turns out that the anisotropic factor is positive and increases monotonically. This suggests that a repulsive contribution offsets gravitational collapse. The model's observational viability is supported by statistical analyses that use a chi-square test to compare theoretical and observed mass values and show strong agreement. Moreover, the compact nature of these stellar configurations is confirmed by surface redshift behaviour. These results demonstrate the function of f(Q) gravity in cosmological and astrophysical settings, providing a framework that is consistent with late-time cosmic acceleration scenarios and an alternative to general relativity for modelling extreme gravitational systems.

Keywords: Anisotropic factor; f(Q) gravity; Chi-Square test.

Investigating IR Cutoff Effects in Fractional Action Cosmology with Holographic Dark Fluid: A Study via GSL and Statefinder Diagnostics

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ABSTRACT

The late-1990s discovery of the universe's accelerated expansion, based on Type Ia Supernovae observations, reshaped modern cosmology. Earlier, cosmic expansion was believed to be decelerating, but the observed acceleration introduced Dark Energy (DE)—a mysterious component with negative pressure, described by the equation of state (EoS) parameter $\omega = p/\rho$, where p is pressure and ρ is energy density. In this study, we consider a spatially flat Friedmann–Robertson–Walker (FRW) universe and examine Holographic Dark Energy (HDE), motivated by the holographic principle, as a viable DE candidate. To model late-time acceleration, we adopt the framework of Fractional Action Cosmology (FAC), a modified gravity theory. In the first phase, the Hubble horizon is used as the infrared (IR) cutoff, and HDE acts as the background fluid. Using a power-law scale factor, we reconstruct the EoS parameter, which displays quintessence-like behavior. The Null, Weak, Strong, and Dominant Energy Conditions (NEC, WEC, SEC, DEC) are evaluated using the obtained energy density and pressure. In the second phase, a generalized IR cutoff is introduced. The EoS crosses the phantom divide, yet retains a quintessence-like nature. We also test the generalized second law of thermodynamics by analyzing entropy evolution. Finally, we use statefinder diagnostics to assess the cosmological behavior under both scenarios.

Keywords: Fractional action cosmology; holographic dark energy; thermodynamics; state finder diagnostic.

Nonextensive Effect on Breather Structures in Unmagnetized Dusty Plasma with Two Different Temperature Ions

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ABSTRACT

Breather soliton dynamics of dust-acoustic waves (DAWs) are examined in an unmagnetized, nonuniform dusty plasma containing negatively charged dust, two-temperature Maxwellian ions, and q-nonextensive electrons. Employing a hydrodynamic fluid model, the Gardner equation (GE), featuring quadratic and cubic nonlinearities, is derived using the reductive perturbation technique. Exact breather and multi-soliton solutions, obtained via the Hirota bilinear method, exhibit localized oscillatory envelopes that cyclically concentrate and disperse energy without dissipation. Breather properties—amplitude modulation, localization, and oscillation period—are significantly controlled by the q-nonextensive parameter and ion temperature ratios. Higher q values yield narrower, more localized envelopes, while ion temperature asymmetries alter their spatiotemporal morphology. These results establish breather solitons as efficient, non-dissipative energy carriers, offering insights into rogue-wave formation, particle acceleration, and energy transport in dusty plasmas, including cometary tails, planetary magnetotails, and interstellar media, and as diagnostic tools for non-equilibrium particle populations in space and laboratory conditions.

Keywords: Breather structure; hirota bilinear method; nonextensive distribution; RPT.

Plasma Technology: A Path to Sustainability

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ABSTRACT

Recent strides in plasma technology are opening doors to sustainable solutions across various fields. While plasma is ubiquitous in nature, its technological potential has only recently been harnessed. Beyond exciting novel applications, contemporary plasma physics research has significantly enhanced existing industrial uses. This review provides a fundamental overview of plasma and its pivotal role in modern scientific pursuits, targeting a broad scientific and technological audience. The paper highlights plasma technology's benefits in diverse areas, including mechanical, chemical, and electrical engineering, as well as medicine. Specific technological applications discussed include semiconductor manufacturing, surface treatment, lighting, plasma cutting, and plasma etching. Furthermore, the review investigates plasma's environmental impact, emphasizing its contribution to sustainability.

Keywords: Plasma; crystals; semiconductors; power.

Doped Metal Oxide Nanostructures for Potential Applications

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ABSTRACT

Doped metal oxide nanostructures have emerged as promising materials for next-generation energy storage technologies due to their tunable physicochemical properties, high surface area, and enhanced electrochemical performance. Doping introduces hetero atoms into the metal oxide lattice, significantly modifying key characteristics such as electrical conductivity, redox activity, ion diffusion pathways, and structural stability. These enhancements make doped nanostructured oxides ideal candidates for applications in super capacitors, lithium-ion batteries, sodium-ion batteries, and hybrid energy storage systems. Common host oxides such as TiO_2, ZnO, MnO_2, and Fe_2O_3, when doped with transition metals or non-metals, demonstrate improved charge storage capacity, rate capability, and cyclic stability. This abstract highlights the critical role of doping in optimizing the electrochemical behavior of metal oxide nanostructures, with a focus on their mechanisms, recent advancements, and future potential in high-performance energy storage device.

Keywords: Nanostructures; energy storage; super capacitors.

A Gravastar Model with Durgapal - Fuloria Metric Potential

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ABSTRACT

In this present work, we have proposed a novel gravastar model as a viable alternative model to the black hole(BH) theory by using the Durgapal-Fuloria metric potential in a (3 + 1) dimensional framework which overcomes the central singularity and event horizon problem. Mazur and Motolla(M-M) introduced the idea of gravitational vacuum condensate star(gravastar) by studying the Bose-Einstein condensation in the gravitational systems. The gravastar solution featured an interior deSitter spacetime along with an external Schwarzschild space-time. A thin shell separates the de-Sitter interior from the exterior region. By utilizing the Durgapal-Fuloria metric potential, the other metric potential in the interior and the shell region have been determined that eliminates the singularity. We have examined the shell region comprising of ultra-relativistic plasma such as proper length, energy and entropy and they are found to be increasing with increasing thickness. Furthermore, we have analyzed the junction conditions that match the interior and the exterior spacetimes, it is observed that the surface energy density and surface pressure are decreasing with increasing thickness. The analysis of speed of sound predicts the stability of the gravastar model. Thus our results yield a complete family of exact solutions for the gravatsar, which are not only non-singular but also stable.

Keywords: Gravastar; Durgapal-Fuloria metric potential; Bose-Einstein condensation.

Designing of an Electrical Equivalent Circuit Inspired from Polar Electrical Response of *Mimosa pudica*

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ABSTRACT

Acharya J. C. Bose had demonstrated through his biophysical experiments that like excitable animal tissues, the excitable plant *Mimosa pudica*, exhibits characteristic response to polar electrical stimulation. He had established that under bipolar method of excitation, i.e. when the electrodes are connected to the pulvini (motor organ) of the plant, the cathodic petiole showed drooping response but there was no such response at the anodic side. In recent times, similar electrophysiological experiments have also reported the ability of *Mimosa* to detect the polarity of the DC electrical stimulus. Consequently, research on development of biosensors based on the peculiar response nature of the plant in presence of polar electrical stimulation, are on the rise. In this backdrop, the present study aimed at developing an electrical equivalent circuit based on bio-electrical circuit of the characteristic excitatory response of *Mimosa* to cathodic electrode. The equivalent circuit was developed using a combination of LEDs (as the response indicator) and diodes. The working principle of the bio-circuit was based on the characteristic response of the diodes which acted as one-way valves for flow of current. From the study, it was found that the proposed equivalent circuit can mimic the characteristic response of *Mimosa* to DC electrical stimulation. Thus, the electrical equivalent circuit may be effectively used for optimization of sensors based on bioinspired technology.

Keywords: Electrical equivalent circuit; bio-inspired technology; *mimosa*; electrical polar response.

Energy Momentum Tensor of a Non-Minimally Coupled Scalar from the Equivalence of the Einstein and Jordan Frames

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ABSTRACT

Unlike the minimally coupled gravity theory, where matter is coupled with gravity in such a manner that one can differentiate the matter and gravity sectors uniquely, the non-minimally coupled theories (NMCT)are distinguished by the intermingling of the two. As a consequence of this, the calculation of the energy-momentum tensor (EMT) in NMCT is beset with an arbitrariness. In this paper, we provide an algorithm based on the well-known equivalence between Jordan frame and Einstein frame formulations, which enables us to construct the EMT for NMCT in a unique way.

Keywords: Non-minimally coupled theories; energy momentum tensor; Jordan frame; Einstein frame.

Lambda Hypernuclei Production Study using Green's Function Method

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ABSTRACT

Strangeness – first discovered in 1947 through a signal observed in a cosmic ray experiment– introduced a new dimension to nuclear physics. The strange particles – hyperons – baryons with a strange quark- are an essential part of the strong interaction where as Hypernuclei- nuclei with hyperon inside - is a unique laboratory to investigate the effect of strangeness in the nuclear domain. These exotic systems are important across scales, from elementary quark states to neutron star. After decades of the discovery, many open questions still remain, like the presence of hyperon inside the neutron star, charge-symmetry breaking of mirror nuclei etc. To solve this, exploring hypernuclei is a great way to approach as Hypernuclei stand as the most well-known systems of strange hadrons. The recent experiments for Λ-hypernuclear spectroscopy in J-PARC (Japan), J-Lab (USA) also emphasizes the importance of this. With this motivation, this work explores theoretically the Λ-hypernuclei production via (K^-, π^-) reactions using the Green's function method, following the work by N. Auerbach et al. [Phys. Lett. 68B (1977)], reformulated with recent data, to describe the elementary process where Λ particle occupies the same or neighboring neutron orbitals to produce hypernuclei generating particle-hole spectrum. The continuum spectra of the hypernuclei can be extracted from the Green's function. This approach provides a refined modern tool to explore Λ-hypernuclear production.

Keywords: Hypernuclei; Green's function; strangeness; Lambda hypernuclei.

^{150}Nd Target Material Fabrication using Evaporation Method

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ABSTRACT

Fabricating nuclear targets requires careful consideration of factors affecting measurement precision, such as material properties, uniformity, and structural integrity. For the nuclear structure study, thin self-supporting targets are highly desirable; in our case, it was 3 mg/cm² of ^{150}Nd. Fabrication of thin self-supporting targets is highly difficult. So, it has been decided to use a very thin mylar as a backing for the purpose of the experiment. Keeping in view the above aspects, an attempt has been made to prepare thin targets of enriched ^{150}Nd by deposing onto a thin Mylar backing using the evaporation technique in a high vacuum evaporation chamber at the target laboratory of IUAC, New Delhi. In this evaporator, the target material can be evaporated by resistive heating as well as by the use of a 2 kW electron gun. During the evaporation, the vacuum was achieved and maintained in the order of 10−6 mbar. The evaporator is also equipped with a quartz crystal thickness monitor that can give the thickness of deposition as well as the rate of evaporation on the crystal. With low vapour pressure elements such as Nd, great care must be taken during the deposition process to prevent loss of material from the source boat.

Keywords: Nuclear structure; ^{150}Nd target; evaporation method.

Competitive Binding of Activator-Repressor in Stochastic Gene Expression

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ABSTRACT

In this paper, we explore the features of a genetic network where the transcription factors (TFs), namely, activators and repressors bind to the promoter in a competitive way. We have developed an analytical method to find the most probable set of parameter values that are unavailable in experiments and even in theories for decades. We study the noisy behavior of the circuit and compare the profile with the network where the activator and the repressor bind the promoter non-competitively. We observe that the noise found in the super-Poissonian region of the competitive genetic circuit is higher than the noise obtained in the same from a non-competitive one. We further notice that, due to the effect of transcriptional reinitiation in the presence of the activator and repressor molecules, there exist some *anomalous characteristic features* in the mean expressions and noise profiles. On top of that, we find low noise in the transcriptional level and high noise in the translational level in presence of reinitiation than in absence of the same. In addition, we find out the method to reduce the noise further below the Poissonian level in competitive circuit than the non-competitive one with the help of some noise-reducing factors.The availability of detailed reaction kinetics of that model could be the powerful tools for future research and analysis.

Keywords: Stochastic process; transcription factors; the fano factor; competitive and non-competitive architecture.

Facilitated Particle Hopping with Open Boundaries: Steady State and Phase Transition

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ABSTRACT

A primary question of interest for non-equilibrium systems is to find the steady state probability distribution, since there is no general formalism for non-equilibrium systems like the well-known Gibbs-Boltzmann distribution for systems in equilibrium. Obtaining such non-equilibrium probability distribution is often an important step to calculate observables of interest and analyse possibility of phase transition. Motivated from such issues, we present facilitated exclusion process with open boundaries on a one-dimensional discrete lattice, where particles can enter and exit through the boundaries. The entrance and exit of the particles as well as their hopping in the bulk, are possible only in the presence of neighbouring particles, making the process facilitated. For certain choices of the entrance and exit rates, we show that the corresponding steady state can be obtained exactly as a matrix product state. We observe that the steady state particle density cannot be less than half, however small(large) the entrance(exit) rate is. For other choices of the rates, we demonstrate the existence of low density, high density and maximal current phases, using Monte Carlo simulations.

Keywords: Facilitated exclusion process; open boundaries; non-equilibrium steady state; matrix product state; phase transition.

Dielectric Studies of Homoeopathic Medicine

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ABSTRACT

The complex relative dielectric properties of homoeopathic medicine with different potencies have been measured using a precision LCR meter in the frequency range of 20 Hz to 2 MHz at room temperature. The electrical and dielectric properties are represented in terms of complex dielectric function ε*(ω), electrical modulus M*(ω), and electrical conductivity σ*(ω). All these parameters are used to explain the various processes associated with the electric and dielectric properties of homeopathic medicine.

Keywords: Precision LCR meter; complex permittivity; electric modulus.

Short Communication on Thermal Dielectric Relaxation in Sodium Silicate

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ABSTRACT

This study explores dielectric relaxation in sodium silicate (Na_2SiO_3), focusing on its direct dependence on temperature across various frequency scales. It examines the contribution of multiple polarization mechanisms to the thermo-active dielectric behavior. Emphasis is placed on low-frequency dielectric dispersion and complex impedance, which significantly influence the relaxation dynamics. To clearly illustrate the process, complex impedance plots are used, offering insight into the material's response under thermal excitation. The analysis provides a concise understanding of how temperature and frequency affect dielectric relaxation, highlighting the interplay of thermal energy and polarization effects in sodium silicate. This comprehensive approach aids in identifying key characteristics governing thermo-active dielectric responses in such materials.

Keywords: Sintering; FESEM; thermo-active dielectric relaxation; complex data plot.

Thermodynamics of Viscous Generalized Chaplygin Gas Model

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ABSTRACT

In this manuscript, we have examined the viscous generalized Chaplygin gas (VGCG) model based on its thermodynamic stability criteria, utilizing an equation of state, $p = -\frac{A}{\rho^{\alpha}}$, where A represents a positive universal constant. We explore how the thermodynamic behaviour of the universe varies with the bulk viscosity parameter, and we analysed the thermal equation of state, which reveals that the equation of state parameter is explicitly a function of temperature alone. We investigate how this viscous exotic fluid contributes to the accelerated expansion of the universe. A noteworthy result arises, suggesting that compliance with the established stability conditions of a fluid requires the viscosity parameters to be negative definite, ensuring that$(\frac{\partial p}{\partial V})_S < 0$ and $(\frac{\partial p}{\partial V})_T < 0$remain valid throughout the evolution. The thermodynamic stability condition of the fluid is stable in an adiabatic context. Additionally, we have noted that the positivity of thermal heat capacity (c_V) is maintained at constant volume, and the third law of thermodynamics is also applicable in this model.

Keywords: Cosmology; bulk viscosity; stability; thermodynamics.

Bow Shocks of Jupiter and Associated Plasma Waves: An Introspective Study

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ABSTRACT

The strong magnetic field of Jupiter can capture charged particles from the solar wind and also particles ejected from Io which are trapped in the inner magnetic belts and are then reflected back and forth between the north and south magnetic poles. This capturing and trapping mechanism has been considered in this paper and a link with the relative position of Jupiter and the timing mechanism for the sunspots showing particularly how the sunspots wrapped around the orbits of Jupiter and Saturn is also discussed. Bow shocks are produced by an encounter of the solar wind with the obstacle to its flow presented by the magnetic field. The formation of bow shocks and their types are classified here including the two foreshock regions. Their spatial distribution and characteristics are critically focused. Plasma waves and the formation of the bow shock of Jupiter have been examined at length and a record of frequency-time spectrogram taken by Voyager 1 has been used for illustration. The spectrogram record exhibits a narrowband emission near 6 kHz during the early part of the time interval. The paper further indicates how the extensive and thick atmosphere of Jupiter experience substantial turbulence due to its rapid rotation which has an indirect influence on the formation of bow shock.

Keywords: Bow shock; solar wind; interplanetary magnetic field; plasma waves.

Space-Dependent Intermittent Feedback can Control Birhythmicity

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ABSTRACT

Birhythmicity is evident in many nonlinear systems, which include physical and biological systems. In some living systems, birhythmicity is necessary for response to the varying environment while unnecessary in some physical systems as it limits their efficiency. Therefore, its control is an important area of research. This paper proposes a space-dependent intermittent control scheme capable of controlling birhythmicity in various dynamical systems. We apply the proposed control scheme in five nonlinear systems from diverse branches of natural science and demonstrate that the scheme is efficient enough to control the birhythmic oscillations in all the systems. We derive the analytical condition for controlling birhythmicity by applying harmonic decomposition and energy balance methods in a birhythmic van der Pol oscillator. Further, the efficacy of the control scheme is investigated through numerical and bifurcation analyses in a wide parameter space. Since the proposed control scheme is general and efficient, it may be employed to control birhythmicity in several dynamical systems.

Keywords: Space-dependent control scheme; analysis; results; control of birhythmicity in other physical systems.

Dynamics of Cosmic Phase Transition for Dark Matter Bose-Einstein Condensation in Tsallis Modified Cosmology

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ABSTRACT

In the course of cosmic evolution, the temperature of a bosonic gas can drop below a critical value, triggering Bose-Einstein condensation at different stages in the Universe's history. In this work, dark matter is modelled as a non-relativistic gravitational condensate described by the Gross-Pitaevskii-Poisson system. We analyze the condensation of bosonic dark matter as an approximate first-order phase transition within the framework of Tsallis cosmology, a non-extensive generalisation of standard cosmology. The study explores the evolution of key cosmological parameters- such as energy density, temperature, redshift, scale factor, Hubble parameter, and deceleration parameter- before, during, and after the condensation phase. Particular attention is given to the mixed phase where normal and condensed dark matter coexist. The temporal evolution of the condensate fraction is examined to determine the duration of the condensation process under Tsallis modifications. Our results show that incorporating BEC dark matter in Tsallis cosmology produces significant deviations from standard cosmological dynamics. Notably, for a representative Tsallis parameter $\beta = 0.35$, the model can naturally account for late-time cosmic acceleration without requiring an additional dark energy component and offers a potential resolution to the Universe's age problem.

Keywords: Bose-Einstein condensation; Tsallis cosmology; Gross-Pitaevskii-Poisson system; dark matter.

Single Crystal Growth of $GdIn_3$

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ABSTRACT

Synthesizing intermetallic compounds containing rare-earth elements has become a widely explored and evolving domain, particularly in understanding condensed matter phenomena. Materials of the RM_3 configuration where *R* denotes a lanthanide and M is often a transition element have drawn substantial interest. These materials show a broad spectrum of physical effects, including magnetic transitions, modifications due to the crystalline electric field (CEF), nontraditional forms of superconductivity, valence fluctuations, strong electron correlation effects, and behaviors that deviate from standard Fermi-liquid theory. $GdIn_3$ is an intermetallic compound comprising gadolinium and indium in a cubic $AuCu_3$-type structure. Gadolinium's localized $4f^7$ electrons ($S = 7/2$, theoretical moment $\approx 7\ \mu^B$) give the compound strong magnetic interactions. Single crystals of $GdIn_3$ have been grown using metallic-flux techniques. After successfully preparing a single crystal, we characterize the material to understandthe structure and quality using X-ray diffraction (XRD) experiments, mainly powder XRDand Laue diffraction experiments. The powder diffraction patterns are analyzed using theFullprof software. With the help of the Rietveld refinement technique, the latticeparameters, position of coordinates of individual atoms, and occupancy have been determined. To check the stochiometry of the grown sample, energy dispersive analysis by x-ray (EDAX) is performed on a polished surface.

Keywords: Metallic-flux; single crystal; X-ray, EDAX.

An Exact Diagonalization Study of Mixed Valence Phenomena Introducing Correlated Hopping Interaction

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ABSTRACT

The effect of correlated hopping of *d*-electrons between Nearest-Neighbor (*NN*) sites on Mixed-Valent systems has been studied with the theoretical support of extended Falicov-Kimball model. Both thermodynamic and ground state properties have been investigated through the exact diagonalization method. The *f*-electron density $< n_i^f >$ decreases with the *f*-level energy (*E*)showing valence transition. The maximum Coulomb Correlation is seen for lower correlated hopping interaction (*K*).The specific heat curves show sharp single-peak structure. However, for higher values of *f*-level energy *E,*an inclination to double-peak structure is observed at higher temperatures (*T*). The system becomes more disordered with the increase of hopping value.

Keywords: Correlated hopping; exact diagonalization method; mixed-valent system; Falicov-Kimball model.

Impact of LQC on Schwarzschild Black Hole Evolution

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ABSTRACT

The general theory of relativity (GTR) and quantum theory (QT) are two of the most important and reliable theories in modern physics. GTR explains gravity and how it performs on large cosmic scales, while QT describes how matter behaves at microscopic levels. However, none of the theory alone can fully explain complicated problems like big bang singularity. Various scientists now believe that a theory of quantum gravity (QG) may provide reasonable features for solving these issues. Generally, Loop Quantum Gravity (LQG) is one of the special features of quantum gravity theories. The implication of LQG on cosmology for the study of our universe is called as Loop Quantum Cosmology (LQC). Within this framework, we focus on the simplest kind of black hole known as Schwarzschild black hole. In this work, we try to analyse the evolution of Schwarzschild black hole by considering interacting dark energy approach in loop quantum cosmology. Our observations predicted that the evaporation time of a Schwarzschild black hole is quicker and hence its life span decreases in the presence of interacting dark energy. Again, we have found that the accretion efficiency(f) is ineffective in the interacting dark energy based LQC. Within this framework, we also study some thermodynamical quantities and astrophysical constraints for the well stability of the model.

Keywords: Accretion and evaporation; loop quantum cosmology; interacting dark energy; Schwarzschild black hole.

Quantifying the Information-Theoretic Measures of a Gaussian Wave Packet using Information Theory

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ABSTRACT

The study represents the quantification of the information-theoretic measures of a Gaussian wave packet using information theory. A wave function localized over a small region of space can be regarded as a wave packet. Initially, a localized wave function at time $t = 0$ is considered in the coordinate space. The momentum space wave function is obtained by taking the Fourier transform of the coordinate space wave function. At later instant of time 't', the time evolution of the wave function $\psi(x,t)$ is obtained in terms of the 'dispersion-time-scale', over which the spreading of the wave packet takes place. The spreading of the wave packet is analyzed in terms of the size of the uncertainties. The wave functions (at time $t = 0$) are used to construct the corresponding probability densities. Later, the probability densities characterizing the information-theoretic measures have been used to compute the numerical values (in atomic unit) of the Shannon ($S_\rho$and S_γ) and Fisher information ($I_\rho$and I_γ) entropies both in the coordinate and momentum space. Further, the numerical values of the Shannon and Fisher information entropies are found to satisfy the Bialynicki-Birula and Myceilski (*BBM*) inequality and the Fisher based uncertainty relation consistently. Thus, the theoretical study explores the validation for quantifying the information-theoretic measures of a Gaussian wave packet using information theory.

Keywords: Fisher entropy; Gaussian wave packet; information-theoretic measures; Shannon entropy.

Atmospheric Electrification and Global Electric Circuits in Planetary Environments: Implications for Climate, Habitability, and Space Exploration

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ABSTRACT

The electrification of planetary atmospheres is a critical factor in understanding atmospheric dynamics, planetary evolution, and the potential for life beyond Earth. This research presents a comprehensive investigation into the mechanisms and implications of atmospheric electrification across multiple planetary bodies, including Earth, Venus, Mars, Jupiter, and Titan. Emphasizing both convective and non-convective charging processes, the study explores the formation and maintenance of global atmospheric electric circuits (GECs), influenced by cosmic rays, ultraviolet radiation, and planetary magnetic fields. Ion-aerosol interactions are identified as key contributors to atmospheric conductivity, varying significantly with planetary conditions. Using a combination of observational data, meteorological analyses, theoretical modeling, and statistical techniques, this work simulates electric currents and charge distributions in diverse planetary atmospheres. Particular attention is given to dust-driven electrification on Mars and ELF (extremely low frequency) resonance signatures as indicators of global circuit activity. The study highlights the role of solar modulation and magnetic variability in altering ionospheric and atmospheric electrical structures. By comparing multiple planetary environments, the research identifies potential electrostatic hazards relevant to future robotic and crewed space missions. The findings offer novel insights into the interplay between electrification, atmospheric stability, and climatic regulation, with broader implications for exoplanet studies and astrobiology. By advancing the understanding of planetary GECs, this work supports the development of predictive models for planetary weather and habitability, contributing to both fundamental planetary science and applied space exploration technologies.

Keywords: Planetary electrification; global atmospheric electric circuits; atmosphere.

Interplay Between Rotating Black Holes and Cosmic Acceleration in the Framework of Brans-Dicke Theory

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ABSTRACT

The discovery of the universe's accelerated expansion is one of the most profound findings in modern cosmology, necessitating a solid theoretical framework. Among the widely accepted approaches, this study explores accelerated expansion within the framework of Brans-Dicke theory by incorporating a dark energy component. Specifically, we investigate the evolution of rotating black holes (RBHs) in the presence of phantom energy—a form of dark energy characterized by a super-negative equation of state. Our analysis shows that during the radiation-dominated era, the accretion of phantom energy has a negligible impact on RBH evolution. However, in the matter-dominated era, a dynamic interplay emerges between radiation accretion and phantom energy accretion. Beyond a certain critical transition time, phantom energy accretion becomes dominant. Due to its negative energy density, phantom energy accelerates the evaporation of RBHs, effectively shortening their lifespans. This effect is especially significant for RBHs that persist beyond the transition time, where phantom energy overtakes Hawking radiation as the primary driver of mass loss.In contrast, RBHs that are already undergoing evaporation or have completed evaporation before the transition time remain largely unaffected. For these black holes, the transition occurs too late to influence their evolutionary paths. Consequently, the inclusion of phantom energy does not alter current observational constraints on the existing RBH population.

Keywords: Phantom energy; hawking evaporation; accretion; rotating black hole.

Chemometric-Based Green Analysis of Chemical Constituents in Indian Mangoes

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ABSTRACT

Aim of this study is the establishment of a green and non-destructive method to predict the chemical attributes (Carbohydrate, crude protein, crude fat and crude fiber) of mango using near infrared spectroscopy together with chemometric approach. The spectra has been recorded for the fifty one different homogenized Indian mango pulp within the range of 700-2500 nm and then wavelength selection method has been applied to reduce the wavelengths for prediction. Association of Official Agricultural Chemists (AOAC) method has been used for reference analysis to determine same and normalized values have been used for developing the model with chemometrics. Multiplicative Scatter Correction (MSC) and second order derivative were used to pre-process of the original spectra and Partial Least Square regression method has been used to develop the prediction model for chemical property analysis of mango. Coefficient of determination for calibration (R_c^2) as well as for validation (R_v^2) has been given the results more than 0.9 for all chemical properties. The results has been indicated that NIR spectroscopy along with chemometrics is giving the promising outcomes and is an efficient method to calculate the overall chemical attributes of mango fruit with green and non-destructive way.

Keywords: Green; non-destructive; near-infrared spectroscopy; mango.

Soliton-Soliton Interaction in a Silicon Waveguide with Two-Photon Absorption Effect using Hirota's Bilinear Method

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ABSTRACT

Silicon photonics has gained significant attention due to their potential application in optical communication for particularly producing optoelectronic devices. Optical soliton in Si waveguide is a delicate balance between dispersion and nonlinear effects. In the optical soliton communication system like Si waveguide, soliton interaction is an extremely important issue that needs to be considered for the transmission of information purpose. In a Silicon waveguide, we have studied solitary wave solutions with the pulse propagation equation that governs the dynamics of solitons by employing the powerful analytical Hirota's bilinear method. The bright soliton, which is a pulse with zero intensity background where the soliton is a localized peak in intensity, solutions are obtained in such a medium with Two Photon absorption effect, one of the important features in Silicon waveguide. Soliton interaction is an extremely important issue for various practical applications in optical communication systems. By using Hirota's bilinear method we obtain the bright two and three soliton solutions to study interaction among them. Our results show that by carefully selecting soliton and medium parameters, soliton-soliton interaction can be controlled which is crucial for various applications in nonlinear systems.

Keywords: Optical solitons; nonlinear Schrodinger equation; two-photon absorption; Hirota's bilinear method.

Effect of Next-nearest-neighbor Coulomb Repulsion on High-T_c Superconductivity within Extended t-J Model

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ABSTRACT

The numerical results on the role of next-nearest-neighbor (NNN) Coulomb repulsion (V')on some ground state properties such as two-hole binding energy, spin-spin correlation, spin gap and charge gap of high-$T_c$cupratesuperconductors are investigated within *t-J* model extended with NN (nearest neighbor) and NNN Coulomb repulsions. We have employed the exact diagonalization (ED) method in our considered 2-holes in an 8-sites tilted square cluster with periodic boundary conditions. V' largely hinders the process of inter-site binding of two holes. The presence of a short-range antiferromagnetic order (AF) in this system is confirmed by the spin-spin correlation function and NNN Coulomb repulsion has a tendency to make longer-range AF order in the system. The spin gap behaviour establishes the overlapping of singlet and triplet states at smaller V'.Charge gap calculation indicates that superconductivity is opposed by NNN Coulomb repulsion.

Keywords: Superconductivity; *t-J* model.

To Study the Prospect of Fibonacci Sequence in Designing a Stable Transfer Function Leading to Low Pass Filter Design

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ABSTRACT

Filter circuit allows a band of frequency to pass through and stop the other. The pass band may be towards the lower side, middle side or higher side of the frequency spectrum. The pass band is selected by RC combination in analog filter and by a proper algorithm in digital filter. Owing to its extensive application in different fields, filter design is highly pursued in the field of physics and electrical engineering. A filter is analysed by its transfer function. The paper is concerned with the prospect of realisation of active analog filter transfer function with Fibonacci sequence. We have, designed stable transfer functions using pairs of consecutive Fibonacci numbers and analysed the bode plots and step responses. Because of ubiquitous nature, Fibonacci polynomials are used in constructing the transfer function. In this paper the number in the pairs are in golden ratio. Few transfer functions are constructed and analysed by the bode plot, step response and simulate the filter response. We have shown that the low pass analog filters can be designed from the Fibonacci sequence transfer functions, which are under damped in nature and the cut off frequency of the filters have a straight relationship with the Fibonacci numbers used in the transfer function.

Keywords: Transfer function; bode plot; step response; low pass filter.

Atomic Positions in Iso-Electronic Structure of Ticosb Half-Heusler Alloy: Effect on Electronic and Thermoelectric Properties

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ABSTRACT

TiCoSb has the potential to recover waste heat at mid-temperature as a thermoelectric material. Theoretical and experimental investigations are carried out to explore the atomic positions of constituent elements of synthesized TiCoSb Half-Heusler (HH) alloy. TiCoSb HH alloy is synthesized by solid state reaction method. In depth structural characterization of the synthesized sample is carried out by the Reitveld refinement of the x-ray diffraction data(XRD). Further, microstructural characterization is performed by the analysis of scanning electron microscope (SEM), and transmission electron microscope (TEM)data. The probable structure of the TiCoSb material is investigated, theoretically by exploring the optimization of structural energy, band structure, and density of states (DOS) using first principle calculations, employing Quantum Espresso software. XRD data reveal that TiCoSballoy is crystallized with F-43m space group. Reitveld analysis of XRD pattern of synthesized TiCoSb reveals that a better fitting is obtained for the atoms with Wyckoff positions, Sb: 4a(0,0,0), Ti: 4b(½, ½, ½), Co: 4c (¼, ¼, ¼),and a vacant 4d position. It is crucial to mention that the lattice thermal conductivity is significantly lower for the synthesized TiCoSb sample. Elemental analysis,employing energy dispersive x-ray, of the synthesized sample confirms the 1:1:1 stoichiometry of Ti, Co, and Sb, indicates the crystallization of TiCoSb sample. Analysis of selected area diffraction (SAED) pattern of the TEM data corroborated with the XRD data. The DOS diagrams and electronic band structure reveals that above mentioned structure is a p-type degenerate semiconductor with a band gap of 1.09 eV. Further, power factor is estimated theoretically, employing BoltzTraP2 software, considering the referred structure.

Keywords: Reitveld refinement; transmission electron microscopy; density functional theory; transport properties.

Recent Advancements on the Study of the Influence of Breakup of Weakly Bound Nuclei on Fusion in Light and Medium Mass Region

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ABSTRACT

In recent decades, nuclear reactions involving weakly bound nuclei have been studied by several research groups working in the field of nuclear physics. Despite the many successes in addressing some heavy-ion fusion reaction outcomes, many puzzling questions still remain. A relatively large number of reactions with weakly bound nuclei have been systematically investigated at the various laboratories around the world. This review discusses the various works, mainly experimental, reported so far with an aim to study the effect of breakup of the stable weakly bound projectiles, ^{6,7}Li and ^{9}Be on fusion with targets of light and medium masses. For lighter and medium systems, like ^{6,7}Li, ^{9}Be+^{64}Zn, ^{6,7}Li+^{59}Co, ^{9}Be+^{27}Al, ^{6,7}Li+^{24}Mg, ^{6,7}Li+^{16}O, ^{6,7}Li+^{12,13}C *etc.*, the compound nuclei decay predominantly by particle evaporation, and so the evaporation residues (ERs) produced from complete fusion (CF) and incomplete fusion (ICF) processes are same, thereby making it difficult to separate the CF and the ICF products. For such systems the measured cross sections corresponds to the total fusion cross sections which is the sum of complete fusion (CF) and incomplete fusion (ICF) cross sections. From these studies, no significant effect of breakup on total fusion (TF) was observed at energies around the Coulomb barrier.

Keywords: Heavy-ion fusion; weakly bound nuclei; breakup; light and medium mass targets.

Recent Advances in the Design and Analysis of Analog and Digital Filters: A Comprehensive Review

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ABSTRACT

The design of filter circuits dates back to the early 20th century and remains a crucial area of research in electrical engineering and applied physics. Filters are electronic circuits that selectively allow signals of certain frequencies while attenuating others. In analog filters, resistor-capacitor (RC) networks determine the cut-off frequency, and operational amplifiers (op-amps) are employed in active filters to amplify signals within the passband. Digital filters, on the other hand, utilize algorithms to manipulate discrete-time signals for desired frequency responses. Real-world filters deviate from the ideal by exhibiting gradual transitions between passbands and stopbands. Various design strategies—such as Butterworth, Chebyshev, and elliptic approximations—are employed to optimize performance based on specific application needs. Increasing the filter order enhances the selectivity and sharpness of the transition region. Digital filter design has gained prominence due to the proliferation of digital signal processing applications. It involves algorithm development for accurate and efficient frequency discrimination in digital systems. Given their widespread use in communication systems, audio processing, instrumentation, and biomedical devices, the study and improvement of filters are of enduring significance. This review surveys the evolution of filter design, highlighting recent theoretical and practical advancements across different domains, and categorizes them by their application fields.

Keywords: Active filter; analog filter; digital filter.

Study on the Structural and Electrical Transport Properties of Hole-Doped Delafossite *p*-$CuCrO_2$

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ABSTRACT

Delafossite compounds are layered ternary oxides well known for their unique ability to exhibit both high carrier conductivity and optical transparency, making them promising candidates for transparent conducting oxides (TCOs). The combined effects of simultaneous cationic and anionic hole doping on the structural, optical, and transport properties of the prototype delafossite $CuCrO_2$ are investigated in this study. A series of polycrystalline samples with the general formula $CuCr_{1-x}M_xO_{2-y}S_y$ (M = Mg, Li) were synthesized via conventional solid-state reaction. Structural analysis confirms phase purity and successful substitution at Cr and O sites. Using Rietveld refinement, the presence of defect species such as $Mg_{Cr}^{\bullet}$, $Li_{Cr}^{\bullet\bullet}$ and $S_O^{\times}$ was confirmed and quantitatively analyzed. Diffuse reflectance (DR) spectra reveal a dominant optical band gap of approximately 3.5 eV, which remains largely unaffected by site-selective hole doping. Electrical transport measurements suggest that dual doping significantly influences carrier concentration and mobility, leading to improved *p*-type conductivity. These findings provide valuable insights into the defect engineering of $CuCrO_2$-based delafossites for potential optoelectronic and thermoelectric applications.

Keywords: Transparent conducting oxides; *p*-type semiconductor; delafossite; electrical transport.

A Theoretical and Experimental Study Strong Erromagnetic Alloys by Tuning their Crystalline Phase

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ABSTRACT

Ferromagnetism is a unusual property that occurs in only a few substances. The common ones are the transition metals iron, Nickel and Cobalt, as well as their alloys and alloys of rare earth metals. It is a property not just of the chemical make- up of a material, but of its crystalline structure and micro structure. Only certain materials, such as iron, Cobalt, nickel and gadolinium, exhibit strong magnetic effects. Such materials are called ferromagnetic, after the Latin word for iron, ferrum. Ferromagnetic alloys are a new class of smart materials, which are receiving considerable interest from the scientific community and industries for actuating and sensing application. The shape memory properties can be controlled and the Martensite micro structure can also be tuned by an applied magnetic field, which leads to large strain in the material. Hence, the large induced strain in these materials is mainly attributed to be rearrangement of Martensite variants . When the magnetic field is applied, the tetragonal crystal structure start to from within the parent austenitic cubic phase, and the resulting strain causes the formation of twin variants. In conventional SMAs , the sample gets deformed when it cooled and the initial state is retained by heating the sample above the Martensitic transformation temperature. But in Ferromagnetic, the sample is exposed to an external magnetic field, which realigns the magnetic moments along the field and hence the variants grow at the expense of other variants resulting in large deformation. Pictorial representation of moment of Martensitic variants in response to an applied magnetic field shown in figure. When ferromagnetic alloy reach their maximum deformation, it remains in the same state even without the magnetic field. As a consequence, the alloys show large magnetic field induced strain with quicker response at low frequencies then other active materials such as Piezoelectric and Magnetostrictive materials. Due to quick response time of less than a Milliseconds and high strain of over 10%. Ferromagnetic alloys are the finest applicants for developing actuators. In addition, an ideal magnetic SMA mast have high actuation stress, high actuation strain, high operating temperature range and high frequency response and also require lok magnetic field for actuation.

Keywords: Ferromagnetism; martensitic transformation; ferromagnetic alloys; shape memory properties.

Machine Learning Approaches for Centrality Determination in Heavy-Ion Collisions

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ABSTRACT

In the context of heavy-ion collisions, centrality determination plays a crucial role as it is directly related to the medium formed by the colliding nuclei and characterizes the degree of overlapping between the colliding nuclei. Traditionally, centrality is characterized by the impact parameter (b) between the two nuclei. The number of nucleons that participate in a collision (N_{part}) and the number of nucleon-nucleon collisions (N_{coll}) are also used as proxies for centrality measurement. However, none of the mentioned quantities can be measured experimentally due to the femtoscopic length scale of the involved nuclei; as a result, they must be derived from the collision data by using other quantities that roughly scale with them. A Glauber model is frequently employed for this purpose. In this study, we explore the Machine Learning (ML) approach to estimate centrality of Au-Au collisions at $\sqrt{s}$ = 200 GeV in terms of the number of participant nucleons (N_{part}). Four different ML regression models, namely, Polynomial Regression, k-Nearest Neighbors, Decision Tree, and Light Gradient Boosting Machine, were implemented and trained on collision data simulated with A Multi-phase Transport model (AMPT). All the models demonstrate excellent predictive performance, showing the potential of machine learning techniques in improving the precision and reliability of centrality determination in heavy-ion collisions.

Keywords: Centrality; N_{part}; machine learning.

Signatures of the Primordial Gravitational Waves from the String-inspired Inflaton Potential

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ABSTRACT

We study the signatures of the primordial gravitational waves generated during the early cosmological inflation driven by a stringy inflaton potential in both minimal and non-minimal frameworks. The inflation potential derived from type IIB/F- theory yields a small tensor-to-scalar ratio $r\sim10^{-3}$ in both minimal and non-minimal frameworks, which is consistent with current observations. We investigate the resulting stochastic gravitational wave in terms of the energy density spectrum $\Omega_{GW}(f)h^2$. In the present study, the stringy potential predicts the energy density of the gravitational waves of the order of 10^{-17}-10^{-16} for the minimal and non-minimal setups, which lie well inside the forecasted range of LIGO and DECIGO detectors, near the pivot frequency scale ~0.01 Hz. These results suggest that the stringy potential may play a crucial role in the tensor sector and primordial gravitational waves apart from the inflationary dynamics.

Keywords: Inflation; string theory; gravitational waves.

Microscopic Modeling of Light Nuclei Fusion Reactions Using the Double-Folding Approach

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ABSTRACT

This study presents a microscopic model for calculating nucleus-nucleus interaction potentials in fusion reactions, focusing on light systems such as $^{12}C + ^{12}C$ and $^{16}O + ^{16}O$, with applications in nuclear physics and stellar nucleosynthesis. Employing the double-folding approach, we compute the nuclear potentials, by integrating the effective nucleon-nucleon interactions over the density distributions of the interacting nuclei, incorporating both direct and exchange components. The density-dependent BDM3Y1 interaction, derived from the G-matrix elements of the Paris potential is utilized to achieve realistic descriptions of the nuclear force. A dedicated Fortran 90 code was developed to perform these complex folding integrals efficiently, enabling the evaluation of the potentials at various separation distances. The model further accounts for nonlocal exchange interactions through a density matrix expansion technique. Initial results indicate that the double-folding method yields detailed potential profiles, clearly revealing the substantial contribution of the exchange term at short inter-nuclear distances and the consequent energy-dependent fusion barriers. This approach offers a robust alternative to phenomenological models and holds promise for deepening our understanding of nuclear reaction dynamics in both laboratory experiments and astrophysical environments. Future work includes refining the treatment of energy dependence, extending the study to other light-ion systems, and computing fusion cross-sections to validate the predictive capabilities of the model.

Keywords: Double-folding model; fusion reactions; nucleus-nucleus interaction; BDM3Y1 interaction.

Advanced Time-Frequency Analysis of X-ray Binary Light Curves for Quasi-Periodic Oscillation Characterization

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ABSTRACT

X-ray binary systems (XRBs) are among the most compact and energetic astrophysical sources, making them nearly impossible to image directly due to their sub-nano-arcsecond angular sizes. However, valuable insight into their inner accretion dynamics can be obtained from their X-ray light curves, emitted by matter falling onto a compact object such as a black hole or neutron star. A key feature observed in these light curves is the presence of Quasi-Periodic Oscillations (QPOs), narrow, coherent peaks in the power spectral density (PSD) that reflect oscillatory processes within the accretion flow. Traditionally, QPOs have been analyzed using Lorentzian fitting in the frequency domain and the Short-Time Fourier Transform (STFT) to observe time evolution. While effective, these methods are limited in their time-frequency resolution. Between 2005 and 2020, wavelet and adaptive basis transform methods were introduced to overcome these limitations, providing a more localized view of QPOs in both time and frequency. However, most previous studies used simple first-order autoregressive models. In this work, we analyze AstroSat X-ray light curves using wavelet-based time-frequency methods to achieve finer resolution and uncover transient or evolving QPO features that may remain hidden in traditional analyses.

Keywords: X-ray binary systems (XRBs); Quasi-Periodic oscillations (QPOs); Wavelet-based time-frequency analysis; AstroSat light curves.

Quantum Signaling Systems and Their Strategic Role in National Security Architecture

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ABSTRACT

This article provides an overview of quantum Communication and specifically quantum signaling systems in national security framework. Quantum entanglement, superposition of quantum states and Quantum Key Distribution (QKD) are the main important features in this context. Quantum Key Distribution (QKD), allows encryption keys to be exchanged with guaranteed detection of eavesdropping . Quantum networks employing entangled photon pairs can provide instantaneously correlated states across strategic nodes, enabling robust authentication and real-time alerting systems. Beyond communication, quantum-enhanced sensing and radar systems can detect stealth aircraft, submarines, or encrypted signals, contributing to scientific and defence system. In high-threat environments, quantum random number generators (QRNGs) also provide superior cryptographic strength for secure decision-making processes. This article provides a review, the role of foundational principles of quantum physics in signaling (broadly in quantum communication) system and recent progress and application in securing data in strategic sectors such as defence, finance and telecommunication. It further examines policy and infrastructure requirements for integrating quantum technologies into national defence system.

Keywords: Quantum signaling; quantum key distribution; quantum communication.

Oscillation Suppression States in Network of Directly and Indirectly Coupled Chaotic Oscillators

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ABSTRACT

Coupled oscillators offer a helpful framework to comprehend a variety of natural systems. Scientific literature on networks of coupled oscillators has investigated a range of cooperative phenomena, including chimera states, phase-locking, synchronization, oscillation suppression, etc. In this study we explore the oscillation suppression states in network of chaotic oscillators interacting through direct-indirect coupling. We report the dynamics of the coupled unit under two different environments: in presence of low asymmetry parameter and in presence of large asymmetry parameter. We study the role of the asymmetry parameter in the transitions among different dynamical states. We use detailed bifurcation analysis to map the transition scenarios in the parameter space.

Keywords: Coupled oscillators; cooperative phenomena; oscillation suppression.

Structural, Optical and Phonon Dynamics Study of Chemically Synthesized Mg Doped $CoFe_2O_4$[$Co_{1-x}Mg_xFe_2O_4$ (x= 0, 0.05, 0.10, 0.15)] Nanoparticles

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ABSTRACT

Ferrimagnetic cubic spinel ferrites are the subject of investigations in the past few decades because of their strong magnetic and dielectric responses. Undoped CoFe2O4 possesses inverse spiel structure and exhibits good chemical and mechanical stability and strong magneto-crystalline anisotropy. In this work structural, optical property and phonon dynamics study of Mg doped $CoFe_2O_4$ nanoparticles (NPs) were investigated. Samples: $Co_{1-x}Mg_xFe_2O_4$[x= 0, 0.05, 0.10, 0.15] were synthesised by using co-precipitation method and were annealed at 900^0C for three hours in a box furnace. XRD, UV-Visible, FTIR, and Raman spectroscopy studies have been performed to analyse these synthesised $Co_{1-x}Mg_xFe_2O_4$NPs. XRD pattern reveals single phase polycrystalline nature of these samples. All XRD peaks are indexed according to JCPDS file (no. 22-1086) and no impurity peak has been detected in the XRD scan. The estimated crystallite sizes of these samples were lying between 45 - 35 ±2 nm. Rietveld refinement of the XRD pattern has been performed and lattice constants, unit cell value and also hopping length [L_A and L_B] that measures the shortest distance between magnetic ions sitting at the tetrahedral and octahedral were estimated. As Mg doping concentration increases lattice constant a = 8.381Å of $CoFe_2O_4$ has been decreased to a = 8.377Å for $Co_{1-x}Mg_xFe_2O_4$ (x= 0.15) sample. Based on the analysis of UV-Visible spectra we have estimated the direct band gap of these NPs and a monotonic decrease of band gap from 2.48 eV [$CoFe_2O_4$] to 2.25 eV [$Co_{1-x}Mg_xFe_2O_4$ (x= 0.15)] it has been noticed. Raman spectra exhibit six distinct vibrational modes near 178 cm^{-1} [$T_{2g}(3)$], 303 cm^{-1} [E_g], 462 cm^{-1}[$T_{2g}(2)$], 550 cm^{-1} [$T_{2g}(1)$], 610 cm^{-1}[$A_{1g}(2)$], 680 cm^{-1}[$A_{1g}(1)$] that corresponds to spinel structure of $Co_{1-x}Mg_xFe_2O_4$ NPs. A correlation between microstructure and optical properties of $CoFe_2O_4$ nanoparticles has been made based on the analysis of experimental data.

Keywords: Ferrites, Spinel Structure, Optical Properties, Vibrational modes.

Understanding the Mechanism Behind the OH Radical Scavenging Ability of Bilirubin: A DFT Study

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ABSTRACT

Free radicals like hydroxyl radicals, superoxide radicals, and singlet oxygen are unstable species, which readily react and damage the crucial biomolecules of our body, like DNA, protein, lipids, etc. Free radicals are responsible for the cause of harmful diseases like cancer, diabetes, heart disease, and cataracts.OH radicals are produced in our body through the Fenton process, the Haber Weiss process, or the photolysis of water, and are harmful and cause structural damage to essential biomolecules. Antioxidants present in our body or taken from outside prevent the proliferation of free radicals by scavenging them. Bilirubin, a yellow compound formed during the breakdown of heme, possesses antioxidative properties, even though bilirubin is neurotoxic at high micromolar concentrations. DFT (Density Functional Theory) is a theoretical approach and a valuable tool for understanding the mechanism behind the role of antioxidants in preventing oxidative stress(OS). OS condition arises due to an excess of free radicals in our body. In this presentation, M062X/6-31+G (d,p) level of theory available in the Gaussian09 software suite, is used to investigate the OH radical scavenging mechanism followed by Bilirubin. Three widely studied mechanisms adopted by an antioxidant, viz. RAF (Radical Adduct Formation), HAT (Hydrogen Atom Transfer), and SET (Single Electron Transfer) mechanisms will be discussed.

Keywords: DFT, antioxidants, bilirubin, OH radical, free radicals.

Study of Intermittency and Factorial Correlations for p-p Collisions at LHC Energies

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ABSTRACT

The study of fluctuations has triggered significant advances in high-energy physics. Large particle density fluctuations within confined regions of phase space have become a popular tool to study the mechanism of multiparticle production. Most of the work on this topic is particularly centred on the technique of scaled factorial moments (SFM), which are capable of suppressing the Poisson-type noise, enabling the exploration of genuine dynamical fluctuations. The small phase space structure of particle distribution can reveal great detail about the underlying dynamics of particle production and hence about the late freeze-out stage of the collision process. Factorial correlators (F_{pq}) are an important addition to the intermittency phenomenon, since they not only can measure local density fluctuations but can also provide extra information about the bin-to-bin correlation between these fluctuations. In this study, an event-by-event intermittency analysis will be performed on the charged particle multiplicity distributions from the datasets generated using different Monte Carlo-based simulation techniques for proton-proton (pp) collisions at different LHC energies. The objective is to investigate the properties of LHC data as predicted by these simulations and to explore the nature of fluctuations and correlations inherent in such high-energy interactions.

Keywords: Intermittency; scaled factorial moments; factorial correlators; Monte Carlo simulation.

First-Principle Studies of Transition Metal Substituted Erbium Sesquioxide (Er_2O_3)

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ABSTRACT

In this current work from first-principles simulations, we have examined the structural, electronic, magnetic, and optical properties of transition metals(TM) doped rare earth erbium sesquioxide (Er_2XO_3, where X = Co, Mn and Ni) using Quantum-ESPRESSO (QE). Here, the core plane wave density functional theory (DFT) functions of QE were provided by the Plane-Wave Self-Consistent Field component. Comparing with the binding energy, density of states and the net charge-transfer, we found that TM doping improved the applications of erbium sesquioxideEr_2O_3 (ERO) in many aspects. Magnetic properties of all the anticipated samples were described very well by spin-polarized calculations within the framework of DFT. Interestingly, the values of total magnetization of all TM substituted ERO samples were substantially enhanced compared to that of pristine ERO. The electronic and optical properties of doped ERO samples were well-tuned by TM atoms.

Keywords: Electronic Structure; rare earth sesquioxide; density functional theory.

Fabrication of thin Targets for Heavy Ion Induced Nuclear Reaction Studies

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ABSTRACT

Uniform thin targets are required for nuclear fusion and quasi-elastic scattering measurement experiments. For our recent experiment performed at the Inter University Accelerator Centre (IUAC), New Delhi, two highly enriched Neodymium isotopes (in oxide form) were procured in limited quantities due to the high cost because of their low natural abundance. Thin films (100-125µgm/cm^2) of targets along with the carbon backings (30µgm/cm^2) are developed using the electron gun evaporation methods. As theoxide targets are difficult to fabricate due to their high melting and boiling points, selection of suitable boat material selection along with the proper environment is important to prevent the targets from the possible contaminations. These targets have been prepared in High Vacuum (HV) evaporation chamber at the target laboratory of IUAC, New Delhi. Detailed fabrication procedure will be discussed during presentation. Following the use of stylus profilometry information about the uniformity in thickness has been obtained. The Energy Dispersive X-ray Spectroscopy (EDS) has further been used to find contaminations from the other possible sources such as from backing and boat materials. The use of these targets has provided good quality in-beam data using Heavy Ion Reaction Analyzer (HIRA) at IUAC, New Delhi. The detail features of the aforesaid fabricated targets will be presented at the conference.

Keywords: High vacuum; high melting points; EDS; electron gun evaporation.

Superheavy Radioactive Elements: Discovery and Possible Extension of Periodic Table

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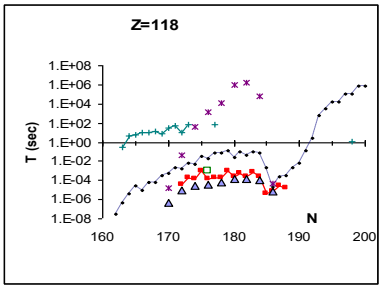
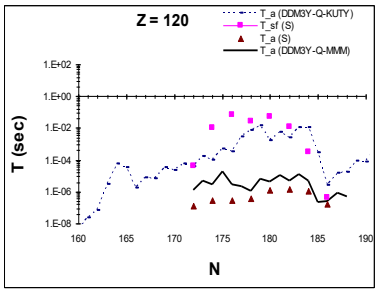
ABSTRACT

Superheavy elements (SHEs) refer to the transactinide elements with atomic numbers Z ranging from 104 to 126and they have a large number of protons in their nuclei. Elements with more than 92 protons are unstable and decay to lighter nuclei. They do not occur naturally on the Earth.SHEs have beensynthesized in various laboratories over the past seventy years using particle accelerators through nuclear fusion reactions involving lighter nuclei. Examples include recently discovered elements like *Nihonium* (113), *Flerovium* (114), *Moscovium* (115), *Livermorium* (116), *Tennessine* (117),and *Oganesson* (118). Despite their instability and limited quantities, SHEs have promising theoretical and applied implications. The alpha (α) decay of SHE is possible if the shell effect supplies the extra binding energy and increases the barrier height of fission. This work explores the possibility of finding long lived superheavy nuclei and highlights the possible extension of periodic table with discovery of new SHEs.Variation of α decay and fission half-lives (T) with neutron number (N)are shown in the following figures for newly discovered SHE Z=118 (*Oganesson*) and Z=120.





Keywords: Superheavy elements; binding energy; α-decay; periodic table.

BALA - Building as a Learning Aid: A Sustainable Innovation in School Infrastructure

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ABSTRACT

School infrastructure is often treated as a financial burden rather than a pedagogical opportunity. This study presents "BALA" (Building as a Learning Aid) as a cost-effective and permanent solution to improve learning outcomes. In a government school in Village- Imlikheda, District Chhindwara (M.P.), the BALA model was implemented during building construction. Walls, floors, and corridors were designed to display mathematical formulas, scientific diagrams, measurement units and more. A four-year analysis of Grade 8 board results revealed a consistent 100% pass rate among students (35, 43, 40, and 22 respectively), without any additional financial input. The visual reinforcement of concepts created a stimulating learning environment, improving comprehension and memory retention. Teachers reported ease in classroom explanation, and students displayed higher interest in subjects like Math and Science. This micro-level intervention, when implemented at scale, could significantly uplift rural education in India by embedding learning into the built environment itself.

Keywords: Learning Aid; BALA; rural education; school infrastructure.

Dielectric, Magnetic and Magnetoelectric Properties of La_2NiMnO_6 Nanoparticles

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ABSTRACT

Nanoparticles of the semiconducting double perovskite La_2NiMnO_6, synthesized via the Pechini method, exhibit distinctive relaxor ferroelectric behavior characterized by a diffusive dielectric phase transition and high dielectric permittivity (~10^3). A significant reduction in the ferromagnetic transition temperature is observed in the nanostructured form compared to the bulk counterpart. The dielectric phase transition is accompanied by macroscopic polarization, as evidenced by P–E hysteresis near liquid nitrogen temperature. The relaxation dynamics conform to the Vogel–Fulcher relation, indicative of glassy polarization behavior. A remarkable colossal magnetocapacitive effect (~30%) is observed under a low magnetic field of 0.5 T in the vicinity of the dielectric transition. Strong magnetoelectric coupling is evident near the ferromagnetic transition temperature (~200 K), suggesting a direct interplay between spin and dipolar degrees of freedom. The dielectric response and relaxor behavior are attributed to nanoscale inhomogeneities, while the magnetocapacitive effect is linked to wave vector–dependent spin-pair correlations. The coexistence of high dielectric permittivity, relaxor ferroelectricity, ferromagnetism, and pronounced magnetoelectric coupling near room temperature underscores the potential of La_2NiMnO_6 nanoparticles for multifunctional device applications.

Keywords: Dielectric; magnetic; perovskite; magnetoelectric.

Synthesis and Study of Very Heavy Elements: Review and Plan

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ABSTRACT

The periodic table, based on electron shell structure, identifies the location and chemical properties of elements. At one time, the periodic table contained only 83 naturally occurring elements, starting with hydrogen and ending with uranium. Since 1940s, physicists have been able to produce unstable elements that decay to lighter elements with half-lives ranging from thousands of years to tiny fractions of a second. Scientists are hoping to stretch the periodic table even further. During the last decade, six new super-heavy elements (SHE) were added into the seventh period of the periodic table, with the approval of their names and symbols. This milestone was followed by proclaiming 2019 the International Year of the Periodic Table of Chemical Elements by the United Nations General Assembly. Discovering the next massive elements will require sophistication of new techniques with ultra powerful ion beams, charged target, cutting edge computational resources, large and complex accelerator and most-advanced detection systems. Apart from a scientific challenge, the synthesis and study of super-heavy elements is also an experimental one. These elements exist solely due to their nuclear shell stabilization. Hence, SHEs provide a unique laboratory to study nuclear structure and dynamics under the influence of large Coulomb forces and ultimately may reveal new physics phenomena to probe the fundamental building blocks of matter. This study is expected to facilitate the planning of future experiments with the production techniques of SHE and challenges involved.

Keywords: Heavy element; fusion-evaporation; decay-chains; recoil separators.

Size-Tunable NiO Nanoflakes for Enhanced Photocatalytic Degradation of Carcinogenic Industrial Dyes and Pathogenic Bacterial Elimination

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ABSTRACT

The escalating release of industrial effluents into aquatic ecosystems has made the elimination of waterborne pollutants an urgent environmental priority. Among various treatment technologies, photocatalysis has emerged as an efficient, cost-effective, and environmentally benign solution. In this study, nickel oxide (NiO) nanoparticle synthesized using advanced chemical method. The synthesized nanoparticles were subsequently sintered at different temperatures, with 450 °C determined to be the optimal sintering temperature. Photocatalytic performance was assessed using Congo Red (CR) as a representative carcinogenic industrial dye and *Escherichia coli* (E. coli) as a model Gram-negative pathogenic bacterium. Structural and physicochemical characterizations, including XRD, FESEM, Raman, and FTIR spectroscopy, confirmed the formation of highly crystalline, phase-pure NiO nanoflakes. The sample sintered at 450 °C (denoted N450) exhibited a bandgap of 3.192 eV, attributed to enhanced surface area and reduced crystallite size. These features, alongside improved interfacial polarization and suppressed photoluminescence, contributed to a remarkable dielectric constant (~193,878), correlating with its superior photocatalytic efficiency. Under optimal conditions, N450 achieved 95.2% degradation of CR within 210 minutes, primarily through the generation of hydroxyl radicals (·OH), as confirmed by scavenger studies. Notably, N450 maintained 91.4% degradation efficiency after four reuse cycles, demonstrating excellent stability. Moreover, N450 displayed strong antibacterial activity against *E. coli*, with >95% inhibition and an inhibition zone exceeding 2.7 mm, attributed to the generation of reactive oxygen species (ROS). These results highlight the promising multifunctionality of NiO nanoflakes for integrated photocatalytic water purification and antimicrobial applications.

Keywords: Electrical dielectric; dye degradation; photocatalytic; scavenger's.

Kinetic Freeze-Out properties at LHC energies

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ABSTRACT

The Relativistic Heavy-ion Collider (RHIC) and the Large Hadron Collider (LHC) are dedicated to recreate conditions of the early universe by colliding heavy ions at near light speed. They have successfully created the new state of matter, Quark Gluon Plasma (QGP). After collisions the system starts to expand due to large pressure gradients and reaches two successive freeze-out stages such as the chemical freeze-out stage andthe kinetic freeze-out stage. To study the properties of the QGP one of the significant observables is transverse momentum (p_T) spectra of produced hadrons. The Boltzmann-Gibbs Blast-Wave (BGBW) model has been widely used to study the $p_T$spectra. In the present work, we fitted the p_T spectra of the produced particles in pp collisions at $\sqrt{s}$ = 5.02 TeV, Xe-Xe collisions at $\sqrt{s_{NN}}$ = 5.44 TeV and Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV and 5.02 TeV for different centrality classeswith the BGBW model.The fitting range was 0.15 - 2.7 GeV/c. Different fit parameters such as kinetic freeze-out temperature (T_{kin}) and the average transverse flow velocity ($\langle\beta\rangle$) have been extracted and compared between the different collision systems. It is observed that the radial flow (β) is independent of the collision energies and multiplicity classes except for very low multiplicity pp collisions. The kinetic freeze-out temperature, T_{kin} shows a clear dependence on the multiplicity classes.

Keywords: Quark gluon plasma; transverse momentum spectra; blast-wave model; freeze-out.

Time-Nonlocal Six-Phase-Lag Generalized Theory of Thermoelastic Diffusion with Two-Temperature

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ABSTRACT

A mathematical model for time-nonlocal six-phase-lag generalized thermoelastic diffusion with two-temperature is proposed for a linear, isotropic and homogeneous thermoelastic diffusive continuum by considering modified Fourier's law of heat conduction together with modified Fick's law of mass diffusion. The modified Fourier's law includes temperature gradient and thermal displacement gradient among the constitutive variables whereas the modified Fick's law includes chemical potential gradient and the chemical potential displacement gradient among the constitutive variables. The Fourier's law of heat conduction is replaced by a fractional order approximation to a modification of the Fourier's law with three different phase lags for the heat flux vector, the temperature gradient and the thermal displacement gradient whereas the Fick's law of mass diffusion is replaced by a fractional order approximation to a modification of the Fick's law with three different phase lags for the mass flux vector, the chemical potential gradient and the chemical potential displacement gradient. The proposed model helps to understand better the behaviour of the considered multi-field coupling and it includes some of the previously proposed thermoelastic diffusion models as special cases. A variational principle is derived and a uniqueness theorem is proved. Finally, a dynamic reciprocity theorem is established for the proposed generalized thermoelastic diffusion model.

Keywords: Generalized thermoelastic diffusion; time-nonlocal six-phase-lag; two-temperature thermoelectricity.

Effect of Molecular Bridging and Channel Spacing on Thermoelectric Transport in Graphene-based Carbon Nanojunctions: A Comparative Study of Carbon Chains, Acetylene and Benzene Bridges

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ABSTRACT

Here we explore the influence of insulator spacers on the thermoelectric and electron transport properties of graphene-based nanojunctions. The system comprises three graphene nanoflakes (GNFs) connected in symmetrically placed between two metallic electrodes via three distinct types of molecular channels: linear carbon atomic chains [C_3-Graphene-C_3], acetylene units [$(C_2H_2)_3$-Graphene-$(C_2H_2)_3$] and benzene rings [$(C_6H_6)_3$-Graphene-$(C_6H_6)_3$]. Here we are investigating the role of these spacers in defining the electronic structure, transmission characteristics and thermal conductance of the system. Using density functional theory (DFT) combined with non-equilibrium Green's function (NEGF) techniques, we investigate how variations in inter-channel spacing and spacer type modulate key thermoelectric properties including the Seebeck coefficient, electrical conductance and thermoelectric figure of merit (ZT). Our findings reveal that carbon atomic chains, acting as quasi-one-dimensional conductors, support strong spin filtering and high Seebeck coefficients under optimized spacing. Acetylene channels provide intermediate behaviour, combining π-conjugation with structural linearity, resulting in a favourable trade-off between conductance and thermopower. Benzene rings, with their rigid π-conjugated frameworks, enable delocalized charge transport but exhibit reduced Seebeck response. The comparative analysis underscores the spacer-dependent nature of charge and heat transport in molecular nanojunctions. These results highlight the importance of both geometric arrangement and molecular identity in modifying thermoelectric performance, offering valuable design principles for next-generation carbon-based energy harvesting devices and open new avenues for molecular-scale energy conversion systems.

Keywords: Spacers; graphene nanoflakes (GNFs); Seebeck coefficient; thermoelectric figure of merit (ZT).

May 2024 Extreme Solar Storms: Causes and Impacts on Space Communication

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ABSTRACT

The solar storms of May 2024 represented one of the most significant space weather eventsof the 21st century, producing multiple X-class solar flares, a rare "cannibal" coronal mass ejection (CME), and G5-class geomagnetic storms that rivalled historical events like the Halloween Storms of 2003. This comprehensive analysis examines the underlying physics, technological impacts, societal consequences, and historical context of these extraordinary solar phenomena, while exploring their implications for our increasingly technology- dependent civilization.

Keywords: Solar storm; magnetospheric turbulence; plasma; waves.

Temperature-Dependent Structural Transition in Ticosb Half-Heusler Alloy: An Experimental and Theoretical Investigation

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ABSTRACT

TiCoSb is a p-type thermoelectric material. Sample is synthesized by solid state reaction followed by arc melting. Low temperature structural and transport properties show an anomaly at low temperature. In-depth long-range temperature-dependent structural characterization is carried out by Rietveld refinement of X-ray diffraction (XRD) data, obtained by employing high energy synchrotron source. Temperature-dependent vibrational spectroscopy is performed, using the Raman spectroscopy (RS) study. In order to reveal the structural change at low temperature, the effect on electronic structure and transport properties, a first principle-based density functional theory (DFT) calculation is performed. The low-temperature structural distortion towards hexagonal phase in TiCoSb based HH alloys is investigated using a combination of experimental and computational approaches. Theoretical calculations confirm that the cubic phase of TiCoSb is a semiconductor, while the hexagonal phase exhibits metallic behavior with no band gap. Experimentally, low-temperature XRD data reveals the emergence of a new diffraction peak below 100 K, indicating a trace of hexagonal Ni_2In (B82-type) structure. This structural transformation is further validated by Rietveld refinement, which shows an anomalous change in unit cell volume, confirming the shifting in different phase. The consistency of this finding with temperature-dependent RS data, particularly the anomalous behavior of thermal conductivity (κ), provides additional evidence of a structural change at ~100 K. Most importantly, the observed structural transformation strongly correlates with the metallic-to semiconducting transition in resistivity data. The anomalous behaviour in structural and electronic properties indicates a formation of hexagonal phase of TiCoSb at low temperature.

Keywords: Reitveld refinement; density functional theory; Raman spectroscopy; structural phase transition.

Structural, Mechanical, Electronic and Optical Properties of Se and Te doped $MoSe_2$: A DFT Study

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ABSTRACT

In this study, structural, electronic, and optical properties of 2D hexagonal monolayer molybdenum diselenide ($MoSe_2$) and its selenium (Se) and tellurium (Te) doped derivatives have been investigated using density functional theory (DFT) incorporated in the SIESTA code. This work comprehensively analyzes band structure, total and partial density of states. Additionally, for thermodynamic stability, the enthalpy of formation and cohesive energy have been evaluated. The substitutional doping of Se and Te into the $MoSe_2$ lattice shows notable variations in the electronic structure, with the cohesive energy per atom changing from -6.566 eV for pristine $MoSe_2$ to -6.635 eV and -6.247 eV for S- and Te-doped $MoSe_2$, respectively. The enthalpy of formation shifts accordingly, indicating stability for all compositions: -1.014 eV (pristine), -1.053 eV (S-doped), and -0.916 eV (Te-doped). The calculated band gaps for $MoSe_2$ and its derivatives, all with direct band gap character, range from 1.4290 eV in S-doped $MoSe_2$ to 1.3012 eV in Te-doped $MoSe_2$, with pristine $MoSe_2$ exhibiting a band gap of approximately 1.3718 eV. Mechanical study analysis shows robust mechanical integrity upon doping. The doping-induced modifications in the electronic and optical responses are expected to tailor the bandgap and enhance the optoelectronic performance of $MoSe_2$ for advanced applications in catalysis, sensing, and next-generation electronic and photonic devices.

Keywords: DFT; mechanical property; electronic property; optical property.

Fabrication of SERS-Active Substrates Through Integration of Langmuir-Blodgett and Self-Assembly Techniques

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ABSTRACT

Surface-enhanced Raman scattering (SERS) spectroscopy has emerged as a powerful analytical tool, capable of significantly amplifying the Raman signals of molecules adsorbed on plasmonic nano-structured surfaces. SERS offers not only the sensitivity to detect the presence of molecules down to the single molecular level but also provides valuable insights into the interaction mechanism of the adsorbed molecules in the vicinity of metal nano-structure. In this work, we present the fabrication of SERS substrates based on the self-assembly of metal nanocolloids entrapped in the Langmuir–Blodgett film templates. Elemental composition and the morphological features of the as prepared substrates are explored from XPS analysis and the FESEM, AFM images respectively. The SERS efficacy of the substrates has been tested with trace concentrations of 4-Mercaptopyridine molecule. Finally, these SERS-active substrates have also been successfully employed for the detection of trace concentrations of pesticides such as thiram and malathion, as well as in other real-world applications.

Keywords: Langmuir-Blodgett film; metal nanocolloid; SERS.

Investigations on the Change in AE Index During Solar Cycle 24

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ABSTRACT

The AE geomagnetic indices can be considered as proxies of the response of the Earth's magnetosphere and ionosphere to solar magnetic activity. They indirectly monitor some electric current systems which flow in the ionosphere and magnetosphere whose dynamics are directly or indirectly related to the Sun–Earth interaction. Consequently, their temporal changes reflect processes occurring in the near-Earth space, which contribute differently to the overall magnetosphere–ionosphere dynamics. In this report, daily plots and hourly values of the AE indices and 'contributing station' plots giving additional information on the indices have been presented. The stations that actually give the AU and AL values are named the 'contributing stations' of the AU and AL indices. The pair of the AU and AL contributing stations is referred to as 'the contributing stations of the AE indices'. The plot identifies these AE contributing stations, and also gives information on the data availability for each station. The plots of AE indices have been thoroughly analysed and the changes have been recorded.

Keywords: Auroral electrojet (AE) index; solar cycle 24; geomagnetic variations.

Spreading and Entanglement in Binary Aperiodic Quantum Walks: The Role of Generic Quantum Coins

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ABSTRACT

Quantum walks are a powerful tool for generating diverse probability distributions and quantum entanglement, making them a significant area of current research. This work numerically investigates how generic quantum coins influence the hybrid entanglement and spreading behavior of binary aperiodic quantum walks. We specifically explore walks with time- and position-dependent coin operations based on Fibonacci, Thue-Morse, and Rudin-Shapiro sequences. Our simulations reveal that the choice of quantum coin profoundly and uniquely impacts each walk's dynamics. Notably, we demonstrate that the dynamic Fibonacci walk can exhibit localized behavior for specific coin parameters. This finding is particularly significant as dynamic coin disorder was previously found to lead only to non-localized behavior, offering a new perspective on its role. Furthermore, we uncover the critical influence of a specific coin parameter that controls the superposition of spin states during coin operation. This parameter allows for distinct tuning of both the spreading and entanglement behavior, enabling a transition from significantly low to high values depending on the coin and operation type. This work advances our understanding of the crucial role of quantum coins in inhomogeneous quantum walks.

Keywords: Quantum walk; quantum coin; quantum entanglement.

Role of Back Contact Work Function and Interface Defect Density in Cu_2O/TiO_2 Thin Film Solar Cell

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ABSTRACT

Semiconducting metal oxides have been a focus of fundamental research due to its suitable electrical and optical properties. In this work, the Cu_2O/TiO_2 thin film heterojunction solar cell has been analyzed with the help of Solar Cell Capacitance Simulator (SCAPS-1D), considering the role of back contact work function and interface defect density. Back contact work function is varied from 4.6 eV to 5.64 eV to study the effect of it on the cell performance and also defect density of Cu_2O/TiO_2 interface has been controlled from 10^{10} cm^{-2} to 10^{15} cm^{-2} to examine the role of it. It is observed from the simulated results that short circuit current density (J_{SC}), open circuit voltage (V_{OC}), fill factor (FF) and power conversion efficiency (PCE) of the proposed solar cell are significantly improved as the value of work function reaches near 5.22 eV. On the other hand, these cell parameters drastically reduce as interface defect density changes from lower to higher values. In addition, using different back contact metals such as Cu (4.6 eV), Ag (4.7eV), Fe (4.8 eV), Nb (4.9 eV), Mo (5 eV), Ni (5.22 eV), Au (5.47 eV) and Pt (5.64 eV), cell parameters (J_{SC}, V_{OC}, FF and PCE) have been calculated at operating temperature of 300 K and interface defect density of 10^{11} cm^{-2}. It is further noticed from the calculated results that short circuit current density (J_{SC}), open circuit voltage (V_{OC}), fill factor (FF) and power conversion efficiency (PCE) are higher for Ni back contact of work function 5.22, and that are respectively 11.375 mA/cm^2, 1.1750 V, 85.01 % and 11.36 %.

Keywords: Work function; interface defect; solar cell; SCAPS-1D.

Tunable Conductivity Switching and Hierarchy of Hysteresis of CdS Quantum Dots Dopped in Poly(methyl methacrylate) Matrix

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ABSTRACT

Switching in current and appearance of hysteresis loop in the current–voltage characteristics of thiol capped CdS quantum dots (QDs) dopped in poly (methyl methacrylate) matrix are presented. The switching phenomenon has been carried out under different external parameters. The bi-stability in current has been found to depend on the sample cell temperature, sweeping voltage, etc. With the increasing sample temperature, the threshold voltage decreases but threshold voltage increases with the increasing sweeping voltage. Between two sweeps, the switching events exhibit hierarchy of hysteresis loops. The area within the hysteresis loops decreases with increasing sample cell temperature and ultimately disappear at higher temperatures. The switching events can be tuned by changing the experimental conditions.

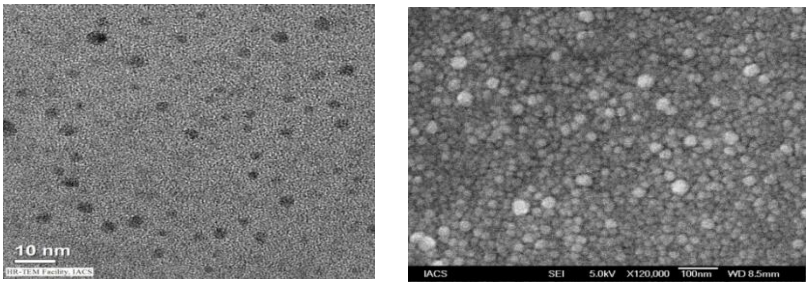

Figure: TEM & SEM images of CdS quantum dots doped in poly(methyl methacrylate) Matrix.

Keywords: CdS quantum dots; conductivity switching; hysteresis.

Structural and Magnetic Behaviour of Ho_2NiTiO_6 Double Perovskite

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ABSTRACT

The double perovskite Ho_2NiTiO_6 has been successfully synthesized and subjected to detailed structural and magnetic analyses. X-ray diffraction combined with Rietveld refinement confirms a monoclinic $P2_1/n$ crystal structure, featuring a notable Jahn-Teller distortion within the NiO_6 octahedra. X-ray photoelectron spectroscopy confirms the presence of high-spin Ni^{2+} and Ti^{4+} cations, consistent with expected oxidation states. Magnetization measurements reveal a long-range antiferromagnetic ordering at $T_N \approx 5.5$ K, accompanied by a negative Curie-Weiss temperature ($\theta_{CW} = -10.9$ K), indicative of predominant antiferromagnetic interactions. The system exhibits a magnetocaloric effect characterized by a broad magnetic entropy change, attributed to the interplay of spin-lattice coupling and geometric frustration linked to bent Ni–O–Ti linkages. Furthermore, the field dependence of the relative cooling power ($RCP \propto H^{1.24}$) points toward a complex interaction between magnetic anisotropy and thermal fluctuations. The coupling among orbital, lattice, and spin degrees of freedom underscores the potential of Ho_2NiTiO_6 as a tunable material for low-temperature magnetic refrigeration applications.

Keywords: Rera-Earth-Based double Perovskite; antiferromagnetism; magnetocaloric.

Synthesis and Structural Characterization of Rare Earth Double Perovskite Compound Ba_2NdNbO_6

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ABSTRACT

The rare earth polycrystalline double perovskite compound Ba_2NdNbO_6 was prepared using conventional solid state reaction method and it was characterized systematically through powder X-ray diffraction and its Rietveld refinement. The XRD profile was analyzed by Rietveld method using a FULLPROF software suite to determine the crystalline phase of the sample. We could confirm from the analysis of Rietveld refinement that this compound is in single-phase and crystallized in perovskite type structure with monoclinic space group *I*2/*m*. The refined cell parameter obtained from this refinement are $a = 6.0767$ Å, $b = 6.0456$ Å, $c = 8.5338$Å, $\beta = 90.134°$ and $V = 313.5095$ (Å)^3. From the most intense peak of X-ray diffraction, the crystallite size was estimated using Scherrer's formula and was thus found to be ~ 42 *nm*.

Keywords: Rare earth, perovskite, X-Ray diffraction, Rietveld refinement.

Some Interesting Physical Features of Two-Dimensional Tetragonal-Silicene: A Theoretical Study

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ABSTRACT

This study is based on combined Density functional theory and tight-binding calculations. Two dimensional tetragonal-silicene is a stable non-hexagonal allotrope based on silicon and buckled in structure. It is semi-metallic possessing two Dirac cones in the irreducible Brillouin zone, thus more versatile than hexagonal graphene. Comparing the Density functional theory and tight-binding calculations band structures, the values of the tight-binding parameters are estimated. It is observed that both the Dirac cones are robust and stable under wide range of hopping parameters. The electronic properties of tetragonal-silicene nanoribbons (TSNRs) show a strong dependence on the width and edge. The symmetric armchair TSNRs show a width dependent multiple Dirac cones, whereas asymmetric armchair TSNRs are semiconducting. Thermoelectric properties like electrical conductivity and figure of merit are better compare to graphene. A transverse electric field transforms the linear spectrum to parabolic at Fermi level and opens a band gap. The gap is similar at both the Dirac points and increases in proportion to the applied field strength. However, a sufficiently strong electric field converts the system into metallic one. A comparable band opening is also observed in the TSNRs. Electric field-induced semiconducting nature improves its thermoelectric properties further.

Keywords: Dirac materials; nanoribbons; electronic properties; thermoelectric properties.

Synthesis and X-ray Rietveld Refinement of Mixed Pyrochlore Compound $Dy_{2-2x}Y_{2x}GaSbO_7$; $x = 0.6$

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ABSTRACT

My present work reports the synthesis and structural characterization of doped rare earth pyrochlore compound with the general formula $Dy_{2-2x}Y_{2x}GaSbO_7$ ($x = 0.2$). The rare-earth element Yttrium (Y^{3+}) was systematically substituted for dysprosium (Dy^{3+}) in the A-site of the pyrochlore lattice to investigate the structural evolution and stability of the resulting compounds. This compound was synthesized via solid-state reaction and characterized systematically through powder X-ray diffraction and its Rietveld refinement. The analysis of Rietveld refinement confirmed the compound was single phase and crystallized in pyrochlore type structure with cubic space group *Fd*3*m*. The lattice parameter obtained from this refinement is 10.184772 Å. The crystallite size was estimated using Scherrer's formula from the most intense X-ray diffraction peak and was thus found to be ~ 60 *nm*.

Keywords: Rare earth, pyrochlore, Rietveld refinement.

Osmotic Stress-induced Changes in GUV Membrane Morphology and Their Effect on Membrane Tension

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ABSTRACT

Cells need a balanced internal and external environment to work properly and stay in one piece. When there's an imbalance, called osmotic pressure, it can stretch and change the cell's outer layer, the membrane. This stretching can even change how flexible the membrane is, leading to its deformation. We use Giant Unilamellar Vesicles (GUVs) as a good model to study how cells function. When we do experiments with GUVs, it's crucial to keep the inside and outside solutions balanced. If not, any osmotic stress makes it harder to understand our results. In this study, we looked closely at how osmotic stress affects GUVs in conditions similar to the body. We made GUVs from a substance called DOPC in a sugar solution. Then, we put these GUVs into different strengths of another sugar solution (glucose) at a normal body pH (7.4) and watched them with a microscope. We kept the first sugar solution (sucrose) constant and changed how much glucose we added to dilute the GUVs. We measured something called the peak-to-peak intensity (Iptp), which is like the brightness of the "halo" around the GUVs in the microscope images. We found that the Iptp changed in a straight line with the amount of glucose. But, as we expected, too much glucose caused the GUVs to burst. Finally, we linked the osmotic stress we created to the membrane tension to understand how this tension caused the changes. we saw in the GUVs' shape.

Keywords: Osmotic stress; giant unilamellar vesicles (GUVs); membrane tension; DOPC.

Role of filtering in Oscillation Revival in Coupled Nonlinear Oscillators

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ABSTRACT

A study on coupled oscillators provides an efficient way of understanding many important phenomenon in different field of science and engineering. Stable oscillations are absolutely necessary in many physical and biological systems. But under different coupling schemes, coupled oscillators may show diverse oscillation quenching states (e.g., amplitude death and oscillation death). We apply filtering mechanism in each local coupling path of the coupled oscillators, since in the case of practical network, the coupling path is not ideal and it may offer dispersion and dissipation. Our study shows that proper change of different filter parameters can revive oscillation from quenching states in each coupled oscillator. We present the mathematical modeling and study the bifurcation diagrams of the coupled systems. We extend our results to different type of coupled nonlinear oscillators and different coupling scheme, also. Electronic circuit based experiment is also done to support our theoretical results.

Keywords: Coupled oscillators; oscillation quenching; oscillation revival; filtering.

Investigation of Astrophysical S-Factor and Thermonuclear Reaction Rate of Some alpha-Induced Reactions by Using Selective Resonant Tunnelling Model

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ABSTRACT

The nuclear fusion reactions are responsible for the creation of light elements in the stellar core in the primordial nucleosynthesis. The fusion reactions at sub-barrier energy regimes (E ~ 1 eV to few keV), govern different fundamental aspects of the primordial nucleosynthesis in compact objects. In this energy regime, the fusion reactions can be explained successfully by quantum mechanical tunnelling through the Coulomb barrier. One of the primary keys to understanding the relationship between stellar evolution and nuclear reaction dynamics is the energy dependence of astro-nuclear observables like astrophysical S-factor and thermonuclear reaction rate. We have studied α-induced fusion reactions by considering the one-step Selective Resonant Tunnelling Model (SRTM). In the present model, the imaginary part of the complex nucleus-nucleus potential has been introduced to describe the absorption inside the nuclear well. As an improvement over our earlier work, in this context, we invoked the idea of double folding model's potential for numerical computation of the astrophysical S-factor and thermonuclear fusion reaction rate. The results of our calculation are compared with those found in the literature. The present results are good in agreement with the experimental results.

Keywords: S-factor; reaction rate; SRTM.

Biodegradable Chitosan and Dipicolinic Acid (DPA): Concentration Dependent Dielectric and Electrical Properties

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ABSTRACT

Biodegradable and sustainable polymer dielectrics are increasingly important for flexible electronics and sensors, offering an eco-friendly solution to electronic waste. In this study, thin films of chitosan doped with organic dipicolinic acid (DPA) were fabricated using a simple solvent casting method with varying DPA contents (0, 10, 20, and 30 wt%) in dilute acetic acid medium.X-ray Diffraction (XRD) analysis showed that increasing DPA disrupts the crystalline structure of chitosan, with 20 wt% DPA yielding the most amorphous morphology. Fourier Transform Infrared (FTIR) spectroscopy confirmed chemical interactions at the molecular level between the carboxyl groups of DPA and the amino groups of chitosan. Dielectric measurements revealed a steady increase in dielectric constant with DPA concentration and frequency, attributed to enhanced dipolar polarization and ionic mobility. Dielectric loss was more prominent at lower frequencies due to dipole relaxation effects. AC conductivity improved with both frequency and DPA content, peaking at 20 wt% with a maximum value of 7.2×10^{-4} $S \cdot m^{-1}$ at 1 MHz. Further addition of DPA reduced conductivity, likely due to excess dopant disrupted charge transport. These findings suggest that the concentration-dependent behavior of chitosan–DPA composites offer a promising biodegradable platform for green electronic materials with tunable dielectric and electrical properties.

Keywords: Chitosan, DPA, biodegradable, dielectric, AC conductivity.

Exploring Multifunctional Prospects of Metal-free Group-IV Carbide Quantum Dots and Their Single Layer Heterojunctions

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ABSTRACT

The recently successful large-area bottom-up synthesis of a two-dimensional honeycomb silicon carbide (SiC) monolayer (Phys. Rev. Lett. 130, 076203 (2023)) has undeniably opened up new avenues for exploring the fascinating physics of graphene-like monolayers across various functional domains. In this study, we have meticulously engineered group-IV carbide monolayers, including SiC, GeC, and their single-layer heterojunction (J. Appl. Phys. 132, 184301 (2022)), to design eighteen stable quantum dots (QDs) and comprehensively investigate their electronic properties, magnetic edge states, and electronic transitions. The QDs are deliberately designed such that the in-plane junction line between two carbide monolayers goes through the middle of the structures. These QDs have been further characterized through circular dichroism and their exceptional sensitivity to environmentally hazardous weakly interacting target gases using Density Functional Theory (DFT) calculations. Notably, QDs with zigzag edges exhibit spin-split electronic states alongside fluorescence signatures extending into the short-wave infrared (SWIR) region. Interestingly, polar SiC-GeC QDs showcases chiral characteristics due to their asymmetric point group symmetry (C_1), as revealed by vibrational and electronic circular dichroism spectroscopy. Moreover, the presence of heterojunctions between distinct carbide components significantly enhances gas sensitivity, reaching approximately upto 70% using DFT-D3 correction, a substantial improvement over their individual counterparts- paving the way for advanced environment-friendly and multifunctional applications.

Keywords: Quantum Dots; SWIR Emission; circular dichroism; gas sensing.

Artificial Neural Network (ANN) Algorithm: A Study

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ABSTRACT

Artificial neural network (ANN) is a special branch of computer science. It is actually the capability of a machine to imitate intelligent human behaviour with the help of simulation in computers. Nowadays, AI is a vital technology that aids in daily social and economic activities. It makes a significant contribution to long-term economic growth and solves a variety of social issues. In this article, I focus on the advantages and applications of artificial neural network in various fields. How the developed and developing countries think about AI is also discussed here.

Keywords: Artificial intelligence; artificial neural network; machine learning; deep learning.

Dominance of the Stapler Mechanism in M1 Bands of A ≈ 80 Nuclei

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ABSTRACT

Magnetic rotational (MR) bands, characterized by sequences of ΔI = 1 levels connected via enhanced magnetic dipole (M1) transitions, have been observed in nuclei across the A = 80, 110, 135, and 195 mass regions. These bands arise from configurations involving high-j proton and neutron orbitals, where angular momentum is generated through the gradual alignment of these orbitals along the total angular momentum vector. Recent studies of ^{75}As and ^{79}Se (A ≈ 80 region) have revealed an alternative "stapler" mechanism for angular momentum generation in the observed M1 band structures, where band structure is developed due to the movement of one of the blades (proton or neutron), while the other blade (neutron or proton) remains stationary. The presence of high-*j* $1g_{9/2}$ proton and neutron orbitals are considered to be the cause for the formation of high-lying negative parity dipole band structures in these nuclei belonging to A ≈ 80 region. Following the initial identification of stapler bands in ^{75}As and ^{79}Se, our systematic investigations of $^{77, 78}$As nuclei have provided compelling evidence for the persistence of this mechanism across multiple isotopes in this mass region. These findings strongly suggest that the stapler mechanism may represent the dominant mode of angular momentum generation in the high-lying negative parity (ΔI = 1) M1 bands of A ≈ 80 nuclei, rather than the conventional magnetic rotation scenario.

Keywords: Magnetic rotational bands; stapler mechanism; high-j orbitals; A ≈ 80 nuclei.

Elucidation of Structural and Electrical Behaviour in 10 mol% Gd-Doped Calcium Molybdate

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ABSTRACT

This study comprehensively investigates the structural and electrical properties of scheelite-type 10 mol% Gd-doped Calcium molybdate (0.1 GCMO), synthesized via the conventional solid-state reaction method. Rietveld refinement of the XRD pattern confirmed the formation of a tetragonal crystal structure, consistent with the space group $I\,4_1/a$. Fourier Transform Infrared (FTIR) spectroscopy was employed to identify the vibrational modes associated with the adsorbed functional groups present in the material. Electrical Impedance spectroscopy analysis revealed that the relaxation behaviour of charge carriers deviates from ideal Debye-type characteristics, confirming a non-Debye relaxation mechanism. The DC conductivity is found to be thermally activated and adheres to the Arrhenius equation, indicative of negative temperature coefficient of resistance (NTCR) behaviour. The ionic conductivity of 0.1 GCMO was found to be 1.83035×10^{-6} S·cm^{-1} at 750 °C.

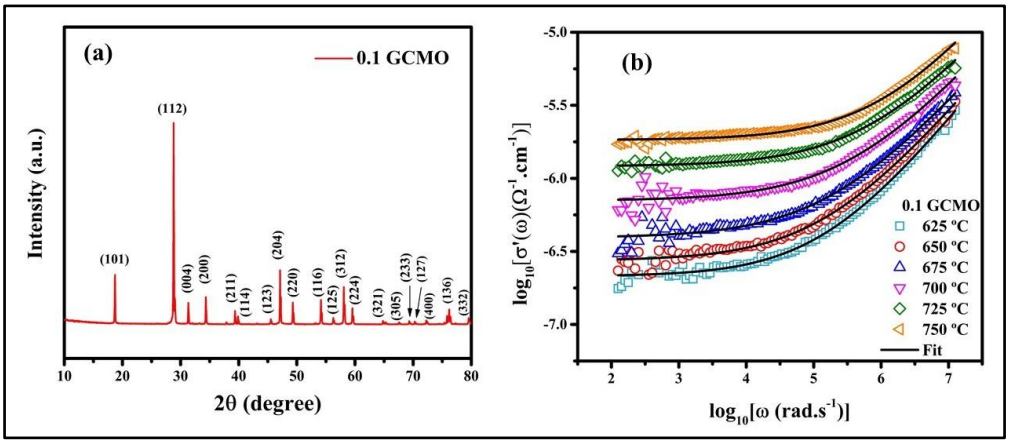

Figure 1. (a) XRD pattern of the synthesized sample; **(b)** AC conductivity spectra recorded at different temperatures.

Keywords: Scheelite; Gd doped calcium molybdate; Eelectrochemical impedance spectroscopy (EIS); AC conductivity.

Structural and Electrical Properties of $La_{0.01}Na_{0.99}NbO_3$ Perovskites

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ABSTRACT

This study investigates the structural and electrical properties of1% La-dopedsodium Niobate ($La_{0.01}Na_{0.99}NbO_3$) perovskite material prepared by the conventional solid-state reaction method. The X-ray diffraction (XRD) pattern of the prepared sample explores the structure of the prepared composition. The sample, sintered at 1150°C temperature for 10 hours, showed an orthorhombic structure with space group $Pmc2_1$. The electrical properties were examined by AC conductivity spectroscopy and impedance spectroscopy analysis in the temperature range between 525°C and 625°C.The rise of the sample's DC conductivity confirms the composition's semiconducting nature. The depressed semicircles of the Nyquist plots reveal that the relaxation mechanism is non-Debye type.

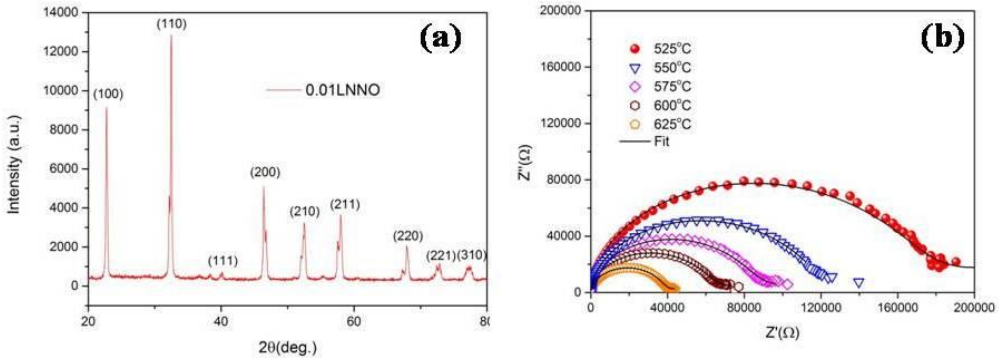

Fig (a) X-ray diffraction(XRD) pattern and (b) Impedance spectra for the sample 0.01LNNO at various temperatures.

Keywords: La-doped Sodium Niobate; X-ray diffraction; impedance spectroscopy; AC conductivity.

The Role of Total Derivative Terms in Higher Order Theory of Gravity

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ABSTRACT

In general, it is believed that the total derivative term does not affect the phase space structure and, correspondingly, the quantum description of a system. Since the Hamiltonians (constructed without taking care of total derivative terms and taking care of the total derivative terms) are related by a canonical transformation, and quantum descriptions are related by a unitary transformation. However, we show that for non-linear higher-order gravity theory, this is not true in general. Specifically for non-minimally coupled Einstein-Hilbert action and dilatonic coupled Gauss-Bonnet action, due to the presence of a coupling term in the Hamiltonian, different unitary transformations are required to relate the two pairs. Since different forms of coupling parameter yield different quantum dynamics. In a nutshell, the unitary transformation relating each pair is not unique. Further for a dilatonic coupled Gauss-Bonnet action, the Hamiltonian following Horowitz formalism or Buchbinder Lyakhovich formalism or Dirac constraint analysis, does not match with classically expected result when the coupling parameters become constant.

Keywords: Canonical transformation; unitary transformation; dilatonic coupled gauss-bonnet action.

Exploring Chaotic Motion of a Particle in the Centre of a Galaxy with a Prolate Halo

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ABSTRACT

The majority of galaxies are known to have supermassive black holes (BHs) at their core, which have a tremendous gravitational pull on the objects around them. When embedded within extended matter distributions like prolate, shell-like halos, they give rise to complex gravitational fields that often drive nearby particles into chaotic orbits. The inherently nonlinear nature of such motion, shaped by general relativity which makes direct analysis highly challenging. To overcome this, pseudo-Newtonian potentials are used to approximate relativistic effects within a Newtonian framework. In this study, we model the central BH using the Paczyński–Wiita (1980) potential for a non-rotating Schwarzschild BH and the Artemova–Björnsson–Novikov (1996) potential to mimic the rotational effects of a Kerr-like BH. The surrounding prolate halo is treated as an axisymmetric, shell-like mass distribution, represented through a third-order multipole expansion including dipole, quadrupole, and octupole components. We explore the resulting orbital dynamics using Poincaré sections, which reveal the emergence of order and chaos under the combined influence of the central BH and the multipolar halo. Our results show that the BH's spin can significantly modulate dynamical behavior, either enhancing or suppressing chaos depending on its direction and magnitude. This study highlights the intricate gravitational interplay between central compact objects and structured halos, offering deeper insight into the dynamic architecture of galactic cores.

Keywords: Supermassive black holes; pseudo-newtonian potentials; chaotic orbital dynamics.

A Monte-Carlo Simulation of Response Characteristics of Nano-Composite Gas Sensors

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ABSTRACT

Sensing process is getting more and more important to detect pollutant gases present in the near atmosphere. In this piece of work response of gas sensors due to adsorption mechanism is studied with Monte-Carlo simulation method. The basic features and the nature of the response of such sensors are reproduced. Quantitative responses of a sensing device under exposure to a gas are analyzed in terms of interacting potentials between adsorbed gas molecules and surface sites of the device. The response of the sensor is assumed to be a linear function of the number of interaction sites. Adsorptions of different concentrations of the gases are studied. Results are consistent and give similar response as the experimental data.

Keywords: Response; Monte-Carlo simulation; gas sensor.

Octahedral Distortion Induced Phonon Vibration and Electrical Conduction in Double Perovskite A_2SmTaO_6 (A =Ba, Sr, Ca)

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ABSTRACT

Disorder plays a central role in critically shaping materials' physical properties. The double-perovskite oxide A_2SmTaO_6 series (A = Ba, Sr, Ca) are systematically studied to show the change in conduction mechanism as the crystal structure deviates from ideal and simplest cubic one. Rietveld refinements of the X-ray diffraction data show that Ba_2SmTaO_6 (BST) crystallizes in cubic phase and Sr_2SmTaO_6 (SST) and Ca_2SmTaO_6 (CST) crystallize in monoclinic phase. The observed shifts of some vibrational modes, studied by Raman Spectroscopy, in the SST and CST w.r.t. BST upon changing the A cation are tentatively explained. Dielectric spectroscopy is applied to investigate the ac electrical conductivity of AST in different temperatures between 303 and 673 K and in a frequency range of 42 Hz–1 MHz. X-ray photoelectron spectroscopy (XPS) measurements are performed in the energy window of 0-1300 eV. The electronic structure investigations of AST have been performed using density functional theory. The calculated DOS is compared with the experimental DOS obtained by XPS. It has been observed that the Sm-f and O-2p states are hybridized in the valence band near the Fermi level. The chemical shifts of the constituent elements determined from the core-level XPS spectra deliver information on charge transfer and nature of chemical bonds. These results have been used to explain the conduction mechanism in these materials.

Keywords: Double perovskites; Phonon Modes; Electronic structure.

Opto-Electronic Visible Light-Based Non-Invasive Blood Glucose Monitoring

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ABSTRACT

Diabetes Mellitus is a chronic condition affecting millions worldwide, necessitating regular blood glucose monitoring. Conventional invasive techniques, such as finger pricking, are painful, costly, and discourage frequent testing. This study presents the design and development of a non-invasive blood glucose monitoring system utilizing visible laser light at a wavelength of 650 nm. The proposed method is based on the optical interaction between glucose molecules and laser light, where variations in glucose concentration affect light refraction and intensity. In vitro experiments were conducted with aqueous glucose solutions, followed by in vivo tests on 110 human subjects, totalling 220 measurements. The photodiode detects the refracted laser light, and a trans-impedance amplifier converts the resulting current into a voltage signal, processed using an Arduino-based data acquisition system. The system incorporates an intensity calibration mechanism using IR-based skin thickness estimation to account for individual variations in skin absorption. Voltage outputs were compared with commercial Accu-Chek glucometer readings, showing a strong linear correlation (95.7% on average). A working prototype was successfully developed, demonstrating the potential of visible light-based, non-invasive glucose monitoring as a practical, pain-free, and cost-effective alternative to current invasive methods.

Keywords: Non-invasive; glucose monitoring; visible laser light; photodiode; Arduino; skin absorption; voltage output.

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