1st INTERNATIONAL CONFERENCE

on

ADVANCES IN PHYSICAL SCIENCES & TECHNOLOGIES

22–24 October 2026

ICAPST-2026

SOUVENIR & ABSTRACTS



Organized by

DEPARTMENT OF PHYSICS

University of Rajasthan, Jaipur - 302004

Rajasthan, India

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PROGRAMME
and
ABSTRACT BOOK

1st International Conference
on
Advances in Physical Sciences & Technologies
ICAPST-2026

Organized by

DEPARTMENT OF PHYSICS,
UNIVERSITY OF RAJASTHAN, JAIPUR

Supported by

अनुसंधान नेशनल रिसर्च फाउंडेशन
ANUSANDHAN NATIONAL RESEARCH FOUNDATION

October 22–24, 2026

Venue:
Department of Physics, University of Rajasthan, Jaipur

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ICAPST 2026

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ABOUT THE UNIVERSITY OF RAJASTHAN

The **University of Rajasthan**, established in 1947, is one of the oldest and most prestigious state universities in Rajasthan, India. Located in the historic city of Jaipur, the University has played a pivotal role in advancing higher education, research, and academic excellence in the region. With its commitment to quality education and research, the University has earned recognition for its academic contributions and institutional development, including its NAAC A+ grade accreditation.

Over the decades, the University has continuously evolved to address emerging challenges in education, scientific research, and technological advancement. Its diverse academic departments, research facilities, and interdisciplinary initiatives provide an enriching environment for students, scholars, and faculty members. The University has made significant contributions to knowledge creation, innovation, and the development of skilled human resources across various disciplines.

With a strong tradition of academic excellence and a forward-looking vision, the University of Rajasthan continues to promote scientific inquiry, interdisciplinary collaboration, and meaningful engagement with society. Through its commitment to research, innovation, and sustainable development, the University remains dedicated to nurturing future generations of scholars and contributing to the advancement of science, technology, and education at national and international levels.

ABOUT THE DEPARTMENT OF PHYSICS

Established in 1960, the Department of Physics, University of Rajasthan, Jaipur, is a distinguished centre for higher education and scientific research, offering postgraduate and Ph.D. programmes in various areas of physics. Over the decades, the Department has developed a strong academic and research tradition, contributing significantly to scientific advancement through fundamental investigations, interdisciplinary research, and technological innovation.

The Department's research activities have received support from several prestigious national and international agencies and scientific organisations, including the University Grants Commission (UGC), Science and Engineering Research Board (SERB), Department of Science and Technology (DST), Department of Electronics and Information Technology, CERN, Board of Research in Nuclear Sciences (BRNS), Defence Research and Development Organisation (DRDO), Council of Scientific and Industrial Research (CSIR), Ministry of New and Renewable Energy (MNRE), UGC–DAE Consortium for Scientific Research (UGC-DAE CSR), Inter-University Accelerator Centre (IUAC), and Indian Space Research Organisation (ISRO).

In recognition of its research excellence and academic contributions, the Department was accorded the status of Centre for Advanced Studies (CAS) by the University Grants Commission for the period 2015–2020. Its major research areas encompass materials science, high-energy physics, plasma physics, nuclear physics, solar energy, hydrogen energy, biophysics, and microwave electronics, reflecting a broad commitment to advancing both fundamental knowledge and applied scientific research.

With its experienced faculty and active research groups, the Department promotes scientific excellence, nurtures young researchers, and advances interdisciplinary research in emerging technologies.

ABOUT THE CONFERENCE

The Department of Physics, University of Rajasthan, Jaipur, is pleased to host the **1st International Conference on Advances in Physical Sciences & Technologies (ICAPST 2026)**, an international forum bringing together scientists, academicians, researchers, scholars, students, and industry professionals to exchange knowledge and discuss recent advances in fundamental and applied physical sciences. The conference provides a platform for presenting innovative ideas, sharing research findings, and engaging in scientific discussions on emerging technologies, contemporary challenges, and future research directions.

ICAPST 2026 aims to encourage young researchers and students to showcase their scientific contributions and interact with eminent scientists, subject experts, and industry professionals. By bridging fundamental research and technological applications, the conference seeks to foster interdisciplinary collaboration, strengthen industry–academia partnerships, and promote innovative solutions for sustainable development.
The scientific programme is organised around **six major thematic tracks**, encompassing diverse and interconnected areas of contemporary research and technological innovation.

1. Advanced Materials and Nanoscience (AMNS)
This track focuses on the synthesis, characterisation, properties, and applications of advanced materials and nanomaterials. It encompasses functional materials, nanostructures, and emerging material technologies with applications in energy, electronics, healthcare, and other scientific and industrial domains. The track aims to promote research into innovative materials that can address contemporary technological challenges.

2. Environmental & Agricultural Systems (EAS)
This track explores the application of physical sciences and emerging technologies to environmental protection, sustainable resource management, and agricultural development. It covers environmental remediation, pollution monitoring, soil and water quality assessment, waste management, recycling, resource recovery, and waste-to-energy technologies. It also encompasses agrophysics and agricultural technologies, including soil characterisation, plant growth, water management, agricultural productivity, and precision farming. The track seeks to advance scientific approaches that support environmental sustainability and resilient agricultural systems.

3. Electronics, Photonics & Intelligent Systems (EPIS)
This track highlights advances in electronics, communication technologies, photonics, optical devices, quantum computing, and artificial intelligence. Key areas include microwave electronics and communication, high-frequency circuits, wireless communication systems, signal processing, laser technologies, optical materials, fibre-optic communication, optoelectronics, and advanced sensing systems. It also explores quantum information processing, machine learning, and AI-driven scientific applications. The track encourages interdisciplinary research towards next-generation communication, intelligent systems, and advanced computing technologies.

4. Energy Storage and Hydrogen Technologies (ESHT)
This track focuses on emerging technologies for efficient energy storage, conversion, and utilisation, with particular emphasis on supporting the integration of renewable energy sources. It encompasses electric energy storage, thermal energy storage, hydrogen production and utilisation, energy conversion

systems, and innovative materials and technologies for improving energy efficiency and reliability. The track aims to promote sustainable energy solutions and advance technologies essential for a cleaner and more secure energy future.

5. Nuclear, Plasma & High-Energy Physics (NPHP)

This track focuses on recent advances in nuclear science, plasma physics, high-energy physics, and cosmology, encompassing fundamental investigations and emerging technological applications. It provides a platform for discussing nuclear structure and reactions, nuclear energy, plasma phenomena and applications, particle physics, and theoretical and experimental studies of the universe. The track seeks to deepen understanding of matter, energy, and the fundamental laws of nature while encouraging scientific exchange across these interconnected disciplines.

6. Renewable & Solar Energy Systems (RSES)

This track emphasises advances in renewable energy technologies, particularly solar energy systems and their applications in sustainable energy generation. It covers solar thermal technologies, including solar heating, solar drying, solar desalination, and thermal energy conversion; materials for solar cells, including advanced photovoltaic materials and approaches to improving solar cell efficiency and performance; and emerging trends in wind and biomass energy, including energy conversion, resource utilisation, and sustainable power generation. The track aims to encourage innovative research and practical solutions for expanding clean energy technologies and reducing dependence on conventional energy sources.

CONFERENCE VISION

Through these six thematic tracks, ICAPST 2026 seeks to provide a comprehensive platform for knowledge exchange, scientific innovation, and interdisciplinary collaboration. By bringing together established experts, emerging researchers, and industry representatives from India and abroad, ICAPST 2026 aspires to promote scientific excellence, nurture young talent, strengthen research partnerships, and advance the contribution of physical sciences and associated technologies to sustainable development and societal progress.

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प्रो. (डॉ.) भगवती प्रसाद सारस्वत
कुलगुरू
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Vice-Chancellor

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पत्रांक :.....

दिनांक : 17.10.2026

Message

It gives me immense pleasure to extend my warm greetings and best wishes for the successful organization of the *1st International Conference on Advances in Physical Sciences & Technologies (ICAPST 2026)*, being organized by the Department of Physics, University of Rajasthan, Jaipur from 22–24 October 2026.

Scientific research and technological innovation are essential for addressing contemporary global challenges and building a sustainable future. Conferences such as ICAPST 2026 provide an important platform for scientists, academicians, researchers, industry professionals, and students from India and abroad to exchange ideas, share recent advancements, and foster meaningful collaborations across diverse fields of physical sciences and emerging technologies.

I am particularly pleased to note the conference's broad coverage of advanced materials, nanotechnology, renewable energy, solar technologies, energy storage, hydrogen energy, high-energy physics, nuclear science and technology, quantum technologies, photonics, plasma physics, and other emerging areas. These interdisciplinary fields play a vital role in advancing fundamental scientific understanding, driving technological innovation, strengthening clean and sustainable energy solutions, and addressing the scientific and technological challenges of the future.

I appreciate the efforts of the organizing committee and the Department of Physics in bringing together the scientific community for this important academic initiative. I am confident that ICAPST 2026 will encourage innovative thinking, nurture young researchers, promote meaningful industry–academia interactions, and establish new avenues for national and international scientific cooperation.

I extend my best wishes to all distinguished speakers, delegates, participants, and organizers for a productive, enriching, and successful conference.

(Prof. Bhagwati Prasad Saraswat)

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Message from the Chief Guest

Scientific progress is driven by curiosity, rigorous investigation, and the pursuit of new knowledge. Bringing together researchers working across diverse areas of physical sciences provides an opportunity to exchange perspectives, identify emerging research directions, and strengthen the scientific foundations of future technologies. In this context, the 1st International Conference on Advances in Physical Sciences & Technologies (ICAPST 2026), organized by the Department of Physics, University of Rajasthan, Jaipur, from 22–24 October 2026, is a valuable academic initiative.

Physical sciences form the foundation of modern scientific discoveries and technological advancements. In an era of rapid transformation, interdisciplinary research and collaboration are essential for addressing complex scientific challenges and translating fundamental discoveries into innovative technologies for the benefit of society. Conferences such as ICAPST 2026 provide a valuable platform for exchanging ideas, presenting emerging research, and strengthening interactions among academic institutions, research centres, and industry.

I am pleased to note that the conference encompasses a wide spectrum of contemporary research areas, including advanced materials, nanotechnology, high-energy physics, nuclear science and technology, plasma physics, photonics, quantum technologies, renewable energy, solar technologies, hydrogen energy, and energy storage. These fields offer exciting opportunities for scientific exploration, technological innovation, and sustainable development.

I commend the Department of Physics, University of Rajasthan, and the organizing committee for their initiative in bringing together the scientific community through ICAPST 2026. I am confident that the conference will stimulate fruitful scientific discussions, encourage young researchers to pursue innovative ideas, and foster meaningful national and international collaborations.

I wish ICAPST 2026 every success and hope that the deliberations will lead to new insights, productive collaborations, and significant contributions to the advancement of physical sciences and emerging technologies.

Prof. Avinash Chandra Pandey
Director, Inter-University Accelerator Centre (IUAC), New Delhi

आचार्य अविनाश चंद्र पांडेय / Prof. A. C. PANDEY
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Department of Physics

University of Rajasthan, Jaipur-302055,
India

Chairperson's Message



The Department of Physics, University of Rajasthan, is delighted to host the *1st International Conference on Advances in Physical Sciences & Technologies (ICAPST 2026)* from 22–24 October 2026. This conference is a significant academic endeavour for our department, bringing together the scientific community to share research experiences, discuss emerging ideas, and explore new possibilities across the diverse domains of physical sciences and technology.

Physics continually enriches our understanding of nature, from the fundamental structure of matter to the complex phenomena that govern the universe. Its principles underpin many of the technological advancements shaping modern society. Recognizing this broad impact, ICAPST 2026 brings together diverse research interests, ranging from high-energy physics, nuclear science, plasma physics, and quantum technologies to advanced materials, nanotechnology, photonics, and renewable energy systems.

A key strength of this conference is the opportunity to connect fundamental research with emerging technological applications. Discussions on solar energy, hydrogen technologies, electric and thermal energy storage, and other sustainable energy solutions are particularly relevant given the growing need for efficient and environmentally responsible energy systems. Equally, exchanges in fundamental and interdisciplinary physics can inspire new approaches to scientific questions and technological challenges.

For our department, ICAPST 2026 is also an opportunity to strengthen academic engagement, encourage research-oriented thinking among students, and build lasting connections with universities, national research laboratories, and international scientific institutions. The participation of eminent scientists alongside early-career researchers and students will make this interaction especially valuable.

I sincerely appreciate the contributions of the organizing committee, advisory members, invited speakers, and all participants whose involvement has helped shape this conference. I hope the scientific sessions will be engaging, the discussions constructive, and the connections established during these three days enduring and productive.

I extend my best wishes to all participants and hope that their engagement in ICAPST 2026 will be both scientifically rewarding and professionally enriching. May the conference foster enduring collaborations, inspire new research directions, and strengthen our shared commitment to scientific advancement and technological innovation.

(Prof. S. K. Gupta)
Head
Department of Physics
University of Rajasthan, Jaipur, India

Convener's Message



It gives me immense pleasure to welcome all the distinguished scientists, academicians, researchers, industry professionals, and students to the 1st International Conference on Advances in Physical Sciences & Technologies (ICAPST 2026), being organized by the Department of Physics, University of Rajasthan, Jaipur, from 22–24 October 2026.

ICAPST 2026 has been conceived as a forum for the exchange of scientific ideas, dissemination of recent research findings, and promotion of meaningful interactions across diverse domains of physical sciences and emerging technologies. The conference aims to bring together researchers from different disciplines to discuss contemporary scientific challenges, explore innovative approaches, and identify opportunities for collaborative research. I hope ICAPST 2026 will provide an intellectually stimulating environment for established scientists and young researchers alike, encouraging scientific curiosity, interdisciplinary engagement, and the development of future research partnerships.

The successful organization of this conference is the result of the collective efforts and support of many individuals and institutions. I express my sincere gratitude to the University administration, the Department of Physics, members of the organizing and advisory committees, invited speakers, reviewers, participating institutions, and all volunteers who have contributed their time and expertise.

I gratefully acknowledge the financial support extended by the Anusandhan National Research Foundation (ANRF), Government of India**,** and the Board of Research in Nuclear Sciences (BRNS), Department of Atomic Energy, Government of India. I also extend my sincere appreciation to our conference sponsors, publication partners, and all other organizations and individuals for their valuable contributions to the successful organization of ICAPST 2026. Their support is vital in creating opportunities for scientific exchange and wider dissemination of research.

I extend my heartfelt appreciation to all authors for contributing their research work and to all delegates for joining us in this collective scientific endeavour. I am confident that the interactions during ICAPST 2026 will strengthen existing academic relationships, encourage new collaborations, and inspire further research and innovation.

I warmly welcome all participants to Jaipur and look forward to three days of stimulating scientific discussions, productive interactions, and valuable academic exchanges. I wish you all a rewarding conference and a pleasant and memorable stay at the University of Rajasthan.

Dr. Sunita Mahavar
Convener, ICAPST 2026

Message from the Organizing Secretaries



Dr. Sanjay Kumar

It gives us great pleasure, on behalf of the organizing team, to welcome you to the 1st International Conference on Advances in Physical Sciences & Technologies (ICAPST 2026), hosted by the Department of Physics, University of Rajasthan, Jaipur, from 22–24 October 2026.



Dr. Arvind Kumar

We are delighted that scientists, academicians, industry professionals, research scholars and students from India and abroad have joined us for these three days. The scientific programme is organized around six tracks: materials science and nanotechnology; environmental and agricultural sciences; photonics and quantum technologies; energy storage and hydrogen technologies; nuclear, plasma and high-energy physics; and renewable and solar energy systems. The programme includes 2 plenary talks, 3 keynote talks and 28 invited talks, including keynote lectures, along with 157 contributed abstracts for oral and poster presentations. This booklet brings these contributions together and will serve as a ready reference during the conference and afterwards.

We sincerely thank the Patron, Prof. B. P. Saraswat, Vice-Chancellor of the University of Rajasthan, for his encouragement and support, and Prof. S. K. Gupta, Head of the Department and Chairperson of the conference, for his constant guidance. We are deeply grateful to the Convener, Dr. Sunita Mahavar, and our colleagues on the organizing committee, the joint secretaries and the treasurers for their dedication in bringing the conference together. We also thank the members of the international and national advisory committees, the invited speakers, the reviewers, and the research scholars, students and staff who have worked tirelessly behind the scenes.

We gratefully acknowledge the financial support of the Anusandhan National Research Foundation (ANRF) and the Board of Research in Nuclear Sciences (BRNS), Department of Atomic Energy, Government of India, and we thank our sponsors for their generous contributions.

We thank all authors and delegates for their valuable participation. We have tried to make your stay in Jaipur comfortable and the sessions smooth, and we request your kind understanding if anything falls short. We hope ICAPST 2026 will be a productive and memorable experience, and that the discussions here will lead to new collaborations and research ideas.

Dr. Sanjay Kumar
Organizing Secretary
ICAPST-2026

Dr. Arvind Kumar
Organizing Secretary
ICAPST-2026

Preface

The 1st International Conference on Advances in Physical Sciences & Technologies (ICAPST 2026), organized by the Department of Physics, University of Rajasthan, Jaipur, from 22–24 October 2026, aims to provide a multidisciplinary platform to present and discuss recent developments in physical sciences and emerging technologies. The conference seeks to encourage the exchange of scientific knowledge, promote interdisciplinary research, and strengthen connections among academic institutions, research organizations, and industry.

Physical sciences form the foundation of numerous technological advancements that shape modern society. Progress in materials science, energy technologies, quantum science, photonics, plasma physics, and related disciplines continues to open new possibilities for scientific discovery and technological innovation. At the same time, global challenges related to energy security, environmental sustainability, and efficient resource use have increased the importance of research focused on sustainable and affordable technological solutions.

In this context, ICAPST 2026 brings together a broad range of research areas, including advanced materials, nanotechnology, solar energy technologies, renewable energy, electric and thermal energy storage, hydrogen energy, nuclear science, plasma physics, photonics, quantum technologies, and artificial intelligence. Particular emphasis is placed on renewable energy and energy storage, which are central to the transition to cleaner energy systems and a more sustainable future. The conference program is designed to facilitate scientific discussions, disseminate recent research findings, and encourage collaborations across these interconnected fields.

This abstract booklet presents a collection of research contributions submitted by participants for presentation at the conference. It provides an overview of the scientific work represented at ICAPST 2026 and serves as a reference for the topics to be discussed through keynote lectures, invited talks, oral presentations, and poster sessions. These contributions reflect the diversity of ongoing research and the scientific community's shared commitment to advancing knowledge and addressing emerging challenges.

The preparation of this booklet and the organization of the conference have involved the dedicated efforts of the organizing committee, reviewers, faculty members, and supporting staff. We gratefully acknowledge the financial support of the Anusandhan National Research Foundation (ANRF), Government of India, and the Board of Research in Nuclear Sciences (BRNS), Department of Atomic Energy, Government of India, as well as the valuable contributions of our sponsors, publication partners, and supporting staff.

We hope this abstract booklet will be a useful academic resource for participants and readers, stimulating further scientific inquiry, encouraging collaborative research, and promoting the exchange of ideas beyond the conference sessions. May ICAPST 2026 contribute meaningfully to the advancement of physical sciences and technologies and inspire future generations of researchers to pursue scientific excellence.

Dr. Sunita Mahavar
Convener, ICAPST 2026
Department of Physics, University of Rajasthan
Jaipur, India

Technical Programme

Day -1: Thursday, 22nd October, 2026 (Humanities Hall, University of Rajasthan)

Time	Programme	Details /Name of Speaker	Place
8:00 AM – 9:00 AM	Registration		Humanities Hall
9:00 AM –10:20 AM	Inaugural Session		Humanities Hall
10:20 AM –11:20 AM	Plenary Talk -1	Prof. Avinash Chandra Pandey (Director, IUAC, New Delhi, India)	Humanities Hall
11:20 AM –11:45 AM	High Tea Break		
11:45 AM – 1:30 PM	Technical Session -I		
11:45 AM –12:45 PM	Plenary Talk -2	Prof. Amare Abebe (NWU, South Africa)	Humanities Hall
12:45 PM – 1:30 PM	Keynote Talk -1	Prof. Kedar Singh (JNU, India)	Humanities Hall
Session Chair	Prof. Ashmore Mawire (NWU, South Africa)		
Session Co-Chair	Dr. Kamlendra Awasthi (MNIT, India)		
1:30 PM – 2:15 PM	Lunch & Networking (Department of Physics)		
2:15 PM – 4:10 PM	Technical Session -II		
2:15 PM – 3:00 PM	Keynote Talk -2	Dr. Maxime Gouzevitch (IP2I – CNRS, France)	Humanities Hall
3:00 PM – 3:40 PM	Invited Talk -1	Dr. Harphool Kumawat (BARC, India)	Humanities Hall
3:40 PM – 4:10 PM	Oral Presentation	RSES-654126; RSES-676573	Humanities Hall
Session Chair	Prof. Amare Abebe (NWU, South Africa)		
Session Co-Chair	Prof. S.K. Sharma (CCSU Meerut, UP)		
4:10 PM – 4:30 PM	Tea/Coffee Break & Networking		
4:30 PM – 5:30 PM	Technical Session -III		
4:30 PM – 5:10 PM	Invited Talk -2	Prof. Ajay Kumar Tyagi (BHU, India)	Humanities Hall
5:10 PM – 5:50 PM	Invited Talk -3	Prof. S.K. Sharma (CCSU Meerut, UP, India)	Humanities Hall
Session Chair	Prof. Maarten Vanierschot (KU Leuven, Belgium)		
Session Co-Chair	Dr. Sanjay Kumar (UoR, Jaipur)		
5:50 PM – 6:15 PM	Day Summary & Panel Discussion (Humanities Hall)		

Day -2: Friday, 23rd October, 2026 (Physics & Geography Department Halls)

Time	Programme Details
8:30 AM – 9:00 AM	High Tea & Networking (DoP)
8:30 AM – 9:00 AM	Poster display time for Poster Session-I (DoP)
9:00 AM –11:20 AM	Parallel Technical Sessions & Tracks

Track & Place	TS -IV: AMNS (DG: Hall-1)	TS -V: EPIS/EAS (DoP: Hall -1)	TS - VI: NPHP (DoP: Hall-2)
9:00 AM – 9:40 AM	IT-04: Dr. Kamlendra Awasthi (MNIT, India)	IT-05: Prof. Suman Rai (Mizoram University, India)	IT-07: Dr. Ashish Kumar Meena (IISc, Bengaluru, India)
9:40 AM 10:20 AM	OP (AMNS): 103980; 114289; 125901; 143558	IT-06: Prof. Manish Shrimali (Central University of Rajasthan, Ajmer, India)	IT-08: Dr. Krishnakumar Ravindran (USS, Chile)
10:20 AM 11:20 AM	OP (AMNS): 197538; 312355; 337530; 371616; 402213	OP (EAS): 121838; 155024; 169817; 244928; 523588	OP (NPHP): 152814; 323223; 378354; 399646; 422929
Session Chair	Prof. Kedar Singh (JNU, New Delhi, India)	Prof. Devendra Kumar Mishra (BHU, UP, India)	Prof. Amare Abebe (NWU, South Africa)
Session Co-chair	Dr. Narendra Jakhar (UoR, Jaipur)	Dr. Pura Ram (UoR, Jaipur)	Mr. Sanjeev Kumar (UoR, Jaipur)
11:20 AM –11:40 AM	Tea/Coffee Break & Networking		
11:30 AM –12:00 PM	Poster Session-I (DoP)		
Poster IDs	PP (30) (AMNS-105067 to 121912; 136043 to 623992)		
Session Chair:	Prof. Arun Pratap (MSUB,Vadodara, India)		
Session Co-chair	Dr. Summaiyya Saleem (UoR, Jaipur)		
12:00 PM – 1:10 PM	Parallel Technical Sessions & Tracks		
Track & Place	TS - VII: AMNS (DG: Hall-1)	TS -VIII: EPIS/EAS (DoP: Hall-1)	TS - IX: NPHP (DoP: Hall-2)
12:00 PM –12:40 PM	IT -09: Prof. Arun Pratap (MSUB, Vadodara, India)	IT-10: Prof. Devendra Kumar Mishra (BHU, UP, India)	IT-11: Dr. Rajnikant Makwana (MSUB, Vadodara, India)
12:40 PM – 1:10 PM	OP (AMNS): 414143; 428981; AMNS-739561	OP (EAS): 594454; 904570; 974086	OP (NPHP): 440105; 760922
Session Chair	Prof. S.K. Sharma (CCSU Meerut, UP, India)	Prof. Neelima Gupta (UoR Jaipur, India)	Dr. Ashish Kumar Meena (IISc, Bengaluru, India)
Session Co-chair	Dr. Subhash Chandra (UoR, Jaipur)	Dr. B. L. Meena (UoR, Jaipur)	Dr. Dalpat Meena (UoR, Jaipur)
1:10 PM – 2:00 PM	Lunch & Networking (DoP)		
1:10 PM – 2:00 PM	Poster display time for Poster Session-II (DoP)		
2:00 PM – 4:00 PM	Parallel Technical Sessions & Tracks		
Track & Place	TS - X: - ESHT/RSES (DG: Hall-1)	TS -XI: - EPIS/EAS (DoP: Hall-1)	TS - XII: - AMNS (DoP: Hall-2)

2:00 PM – 2:40 PM	IT-12: Prof. Ashmore Mawire (NWU, South Africa)	IT-14: Prof. Neelima Gupta (UoR Jaipur, India)	IT-16: Dr. Harsh Soni (IIT Mandi, India)
2:40 PM – 3:20 PM	IT-13: Prof. Thakur Prasad Yadav, (University of Delhi, India)	IT-15: Mr. Kartikey (Director-Programmes Vatsalaya)	IT-17: Dr. C.S.P. Tripathi (BHU, India)
3:20 PM – 4:00 PM	OP (ESHT): 614715 (RSES): 302044; 412805; 786128	OP (EPIS): 149001; 195154; 846199; EAS-715787.	OP (AMNS): 502332; 508538; 545617; 554799
Session Chair	Dr. Namrata Sengar (University of Kota, India)	Dr. Jitendra Singh (CSIR-CEERI Pilani, India)	Prof. Arun Pratap (MSUB Vadodara, India)
Session Co-chair	Dr. Suchitra Yadav (UoR, Jaipur)	Dr. Kishan Kumar (UoR, Jaipur)	Dr. Amanpal Singh Clair (UoR, Jaipur)
4:00 PM – 4:20 PM	Tea/Coffee Break & Networking		
4:10 PM – 4:40 PM	Poster Session-II (DoP)		
Poster IDs	PP (08) (EAS-130162 to 918657); PP (05) (EPIS-350938 to 964334) PP (20) (NPHP: 167679 to 976086)		
Session Chairs	Prof. Neelima Gupta (UoR, Jaipur) & Dr. Rajnikant Makwana (MSUB, India)		
Session Co-chair	Dr. Jyoti Saini (UoR, Jaipur)		
4:40 PM – 6:00 PM	Parallel Technical Sessions & Tracks		
	TS - XIII: RSES/ ESHT (DG: Hall-1)	TS -XIV: EPIS (DoP: Hall-1)	TS - XV: AMNS (DoP: Hall-2)
4:40 PM – 5:20 PM	IT-18: Prof. Maarten Vanierschot (KU Leuven, Belgium)	IT-20: Dr. Jitendra Singh (CSIR-CEERI Pilani, India)	IT-21: Dr. Archana Tiwari (BHU, India)
5:20 PM – 6:00 PM	IT- 19: Dr. Dilip Kumar Meena (HNB Garhwal University, Uttarakhand, India)	OP (EPIS): 402750; 530659; 820724;	OP (AMNS): 779814; 800803; 801088
Session Chair	Prof. Ashmore Mawire (NWU, South Africa)	Prof. Manish Shrimali (Central University of Rajasthan, Ajmer, India)	Dr. Sarita Kumari (UoR Jaipur, India)
Session Co-chair	Dr. Sunita Mahavar (UoR, Jaipur)	Dr. Kanchan Gehlot (UoR, Jaipur)	Dr. Amanpal Singh Clair (UoR, Jaipur)
6:00 PM – 6:15 PM	Day Summary & Panel Discussion (Hall-1)		

Day-3: Saturday, 24th October, 2026 (Physics & Geography Department Halls)

Time	Programme Details & Place		
8:30 AM – 9:00 AM	Breakfast & Networking (DoP)		
8:30 AM – 9:00 AM	Poster display time for Poster Session-III (DoP)		
9:00 AM –11:10 AM	Parallel Technical Sessions & Tracks		
Track & Place	TS - XVI: NPHP (DG: Hall-1)	TS -XVII: AMNS (DoP: Hall-1)	TS -XVIII: EAS/RSES (Online/offline) (DoP: Hall-2)
9:00 AM – 9:40 AM	IT-22: Prof. Subhashish Banerjee (IIT Jodhpur, India)	IT-23: Dr. Komal Bapna (NPL New Delhi, India)	IT-24: Purushottam Soni (Marian University, USA) (Online)
9:40 AM 10:20 AM	OP (NPHP): 451512; 630394	OP (AMNS): 849471; 872796; 888373	IT-25: Prof. A.A. Sagade (UTA, Chile) (Online)
10:20 AM 11:10 AM	OP (NPHP): 902252; 930348	OP (AMNS): 127867; 925680;	OP: EPIS-634772; ESHT-223285; RSES-350502;
Session Chair	Dr. Maxime Gouzevitch (IP2I – CNRS, France)	Dr. C.S.P. Tripathi (BHU, India)	Dr. Manisha Gupta (UoR, India)
Session Co-chair	Dr. Dinesh Kumar (UoR, Jaipur)	Dr. M. K. Gora (UoR, Jaipur)	Mrs. Priyanka Meena (UoR, Jaipur)
11:10 AM –11:30 AM	Tea/Coffee Break & Networking		
11:20 AM –11:50 AM	Poster Session-III (DoP)		
Poster IDs	PP (16) (AMNS-133249; 676255 to 939235); PP (04): (ESHT-124613 to 669126); PP (12): (RSES-100930 to 996464)		
Session Chairs	Prof. Suman Rai (Mizoram University, India)		
Session Co-chair	Dr. Chhagan Lal (UoR, Jaipur)		
11:50 AM – 1:00 PM	Parallel Technical Sessions		
	TS - XIX: ESHT/ RSES (DG: Hall-1)	TS -XX: AMNS (DoP: Hall-1)	TS -XXI: Online (DoP: Hall-2)
11:50 AM –12:30 PM	IT-26: Dr. Subhradeep Mistry (HNB Garhwal University, Uttarakhand, India)	IT-27: Prof. Paolo Mele (SIT, Japan) (Online)	IT-28: Dr. Mohammed Saquib Khan (IRC-SES, KFUPM, Dhahran, Saudi Arabia)
12:30 PM – 1:00 PM	OP (ESHT): 832367 (RSES): 441012; 515668	OP (AMNS): 488309; 993943; 817435	OP (AMNS): 364523; 545617; 579001; 872489; 90865
Session Chair	Prof. Thakur Prasad Yadav	Dr. Komal Bapna (NPL New Delhi, India)	Dr. Harsh Soni (IIT Mandi, India)

	(University of Delhi, India)		
Session Co-chair	Dr. J. K. Mishra (UoR, Jaipur)	Dr. Rekha Yadav (UoR, Jaipur)	Dr. Mamraj Singh (UoR, Jaipur)
1:00 PM – 1:50 PM	Lunch & Networking		
1:50 PM – 2:50 PM	Technical Session-XXII		
1:50 PM – 2:50 PM	Keynote Talk-3 (online)	Prof. K.S. Reddy (IIT Madras, India)	Hall-1
Session Chair	Prof. Subhashish Banerjee (IIT Jodhpur, India)		
Session Co-chairs	Dr. Manisha Gupta & Dr. Arvind Kumar (UoR, India)		
2:50 PM – 3:50 PM	Panel Discussion & Valedictory function		
3:50 PM – 8:00 PM	City Tour & Dinner (Exclusive to participants who have paid the additional fee)		

*** Time Slots:**

Plenary Talk - 1 h; Keynote Talk: 45 min; Invited Talk: 40 min; Oral Presentation: 10 min.

***DG**:- Department of Geography, **DoP**:- Department of Physics; **IT**:- Invited Talk; **OP**:-Oral Presentation; **PP**:- Poster Presentation **NPHP**: Nuclear, Plasma & High-Energy Physics; **AMNS**: Advanced Materials & Nanoscience; **ESHT**: Energy Storage & Hydrogen Technologies; **RSES**: Renewable & Solar Energy Systems; **EPIS**: Electronics, Photonics & Intelligent Systems; **EAS**: Environmental & Agricultural Systems.

Abstract IDs & Presentation Mode

Track- AMNS

Full Name	Abstract ID	Presentation Mode	Full Name	Abstract ID	Presentation Mode
Ajay Tripathi	ICAPST-2026-AMNS-143558	Oral	Laxman Prasad Gurjar	ICAPST-2026-AMNS-227837	Poster
Ankur M Kumar	ICAPST-2026-AMNS-801088	Oral	Babli Kumari	ICAPST-2026-AMNS-272922	Poster
Arshpreet Singh	ICAPST-2026-AMNS-554799	Oral	Shivani Deshwal	ICAPST-2026-AMNS-287291	Poster
Bhanu Pratap Singh	ICAPST-2026-AMNS-312355	Oral	Ashok Saini	ICAPST-2026-AMNS-294974	Poster
Chandra Prakash Barupal	ICAPST-2026-AMNS-428981	Oral	Neha	ICAPST-2026-AMNS-340765	Poster
Chithra B	ICAPST-2026-AMNS-414143	Oral	Riyaz	ICAPST-2026-AMNS-355969	Poster
Devendra Kumar Mahawar	ICAPST-2026-AMNS-502332	Oral	Deepa Yadav	ICAPST-2026-AMNS-398944	Poster
Dr. Anup Thakur	ICAPST-2026-AMNS-508538	Oral	Neha Motwani	ICAPST-2026-AMNS-421548	Poster
Dr. Abhay Dasadia	ICAPST-2026-AMNS-371616	Oral	Amit Kumar Meena	ICAPST-2026-AMNS-422050	Poster
Dr. Deepali	ICAPST-2026-AMNS-337530	Oral	Nidhi Yadav	ICAPST-2026-AMNS-445849	Poster

Dr. Shivaswamy M B	ICAPST-2026-AMNS-925680	Oral
Dr. Vanarajsinh Solanki	ICAPST-2026-AMNS-488309	Oral
Manisha Bajpai	ICAPST-2026-AMNS-125901	Oral
Margi Solanki	ICAPST-2026-AMNS-103980	Oral
Ms. Manisha	ICAPST-2026-AMNS-114289	Oral
Ms. Manju	ICAPST-2026-AMNS-993943	Oral
Neeraj Kumar Singh	ICAPST-2026-AMNS-402213	Oral
Nitesh Sevakram Koche	ICAPST-2026-AMNS-888373	Oral
Rajeev Dwivedi	ICAPST-2026-AMNS-849471	Oral
Rajneesh Kuldeep	ICAPST-2026-AMNS-800803	Oral
Sarjana Yadav	ICAPST-2026-AMNS-127867	Oral
Sharika Afreen	ICAPST-2026-AMNS-872796	Oral
Shrikant Verma	ICAPST-2026-AMNS-779814	Oral
Teena Meena	ICAPST-2026-AMNS-197538	Oral
Dr. Vanarajsinh Solanki	ICAPST-2026-AMNS-488309	Oral
Manroop Singh	ICAPST-2026-AMNS-993943	Oral
Shubha Vats	ICAPST-2026-AMNS-739561	Oral
Suresh Kumawat	ICAPST-2026-AMNS-105067	Poster
Sahil Singh	ICAPST-2026-AMNS-108166	Poster
Rahul Pilania	ICAPST-2026-AMNS-112684	Poster
Meghraj Saini	ICAPST-2026-AMNS-121912	Poster
Anuradha Singh	ICAPST-2026-AMNS-133249	Poster
Neha Chauhan	ICAPST-2026-AMNS-136043	Poster
Nisha Rajput	ICAPST-2026-AMNS-157602	Poster
Nupur Rana	ICAPST-2026-AMNS-224099	Poster
Anil Kumar	ICAPST-2026-AMNS-364523	Online
Prithvi Raj	ICAPST-2026-AMNS-545617	Online
Veenu Sisodia	ICAPST-2026-AMNS-579001	Online
Pashupati Pratap Neelratan	ICAPST-2026-AMNS-449143	Poster
Avinash Vyas	ICAPST-2026-AMNS-463678	Poster
Damini Dahiya	ICAPST-2026-AMNS-474336	Poster
Komal	ICAPST-2026-AMNS-479570	Poster
Dr. Ritu Saharan	ICAPST-2026-AMNS-506225	Poster
Gopal Sharma	ICAPST-2026-AMNS-506225	Poster
Balkar Singh	ICAPST-2026-AMNS-508538	Poster
Ram Naresh Meena	ICAPST-2026-AMNS-531201	Poster
Pavithra N	ICAPST-2026-AMNS-543128	Poster
Anshul Khandelwal	ICAPST-2026-AMNS-562927	Poster
Chandra Prakash Barupal	ICAPST-2026-AMNS-581140	Poster
Sandeep Kumawat	ICAPST-2026-AMNS-613707	Poster
Hemanth B S	ICAPST-2026-AMNS-620923	Poster
Ravila Meena	ICAPST-2026-AMNS-623992	Poster
Sunita Kumari	ICAPST-2026-AMNS-676255	Poster
Ajai Krishnan	ICAPST-2026-AMNS-713522	Poster
Malavika RK	ICAPST-2026-AMNS-719802	Poster
Ankit Kumar	ICAPST-2026-AMNS-736122	Poster
Komal Sharma	ICAPST-2026-AMNS-737750	Poster
Cheshta	ICAPST-2026-AMNS-745047	Poster
Nithin Gowda B S	ICAPST-2026-AMNS-782731	Poster
Dr. Rajni Bala	ICAPST-2026-AMNS-785170	poster
Jay Sharma	ICAPST-2026-AMNS-814596	Poster
Surbhi Sharma	ICAPST-2026-AMNS-817435	Poster
Elen Mary Shaju	ICAPST-2026-AMNS-870805	Poster
Santosh Yadav	ICAPST-2026-AMNS-872489	Poster
Arun	ICAPST-2026-AMNS-908655	Online
Muskan	ICAPST-2026-AMNS-918784	Poster

Bineesha C	ICAPST-2026-AMNS-939235	Poster

Track NPHP

Full Name	Abstract ID	Presentation
Ashna B	ICAPST-2026-NPHP-902252	Oral
Dipankar Ray	ICAPST-2026-NPHP-930348	Oral
Dr. Shabana Khan	ICAPST-2026-NPHP-152814	Oral
Dr. Supriya Devi	ICAPST-2026-NPHP-760922	Oral
Garima Punetha	ICAPST-2026-NPHP-378354	Oral
Kavin Dashora	ICAPST-2026-NPHP-323223	Oral
Lata Panwar	ICAPST-2026-NPHP-630394	Oral
Manan	ICAPST-2026-NPHP-399646	Oral
Ritesh Pandey	ICAPST-2026-NPHP-451512	Oral
Shyamalee Bora	ICAPST-2026-NPHP-440105	Oral
Varsha KV	ICAPST-2026-NPHP-422929	Oral
Anil Kumar Yadav	ICAPST-2026-NPHP-167679	Poster
Manthan Singh Shekhawat	ICAPST-2026-NPHP-205601	Poster
Divyansh Vaishnav	ICAPST-2026-NPHP-211250	Poster
Patel Jinendra Rameshbhai	ICAPST-2026-NPHP-217509	Poster
Ram Kumar Meena	ICAPST-2026-NPHP-239179	Poster
Manisha Verma	ICAPST-2026-NPHP-336717	Poster
Mukesh Kumar	ICAPST-2026-NPHP-338892	Poster
Mukta Saini	ICAPST-2026-NPHP-338892	Poster
Karnawati	ICAPST-2026-NPHP-393163	Poster
Kuldeep Singh	ICAPST-2026-NPHP-529965	Poster
Priya Meena	ICAPST-2026-NPHP-608570	Poster
Vikram Itkan	ICAPST-2026-NPHP-694059	Poster
Avitesh Agrawal	ICAPST-2026-NPHP-820959	Poster

Track EPIS/EAS

Full Name	Abstract ID	Presentation
Abdullahi Tanimu	ICAPST-2026-EPIS-195154	Oral
Dr Hemlata Dharmashaktu	ICAPST-2026-EAS-523588	Oral
Dr. Abhijeet Singh	ICAPST-2026-EPIS-402750	Oral
Dr. Piya Roychoudhury	ICAPST-2026-EAS-155024	Oral
Dr. Suman Garia	ICAPST-2026-EAS-974086	Oral
Harshitha P	ICAPST-2026-EAS-169817	Oral
Hubertwell Thabah	ICAPST-2026-EAS-121838	Oral
Keerthi S	ICAPST-2026-EAS-594454	Oral
Kishore B	ICAPST-2026-EAS-904570	Oral
Manoj Tripathi	ICAPST-2026-EAS-244928	Oral
Praveen Kumar Yadav	ICAPST-2026-EPIS-149001	Oral
Shruti Jangir	ICAPST-2026-EPIS-530659	Oral
Sugar Singh Meena	ICAPST-2026-EPIS-820724	Oral
Suyog Munshi	ICAPST-2026-EPIS-846199	Oral
Marshal Thabah	ICAPST-2026-EAS-130162	Poster
Jeevitha N	ICAPST-2026-EAS-159244	Poster
Dr. Narendra Babu Simhachalam	ICAPST-2026-EAS-375452	Poster
Vidhi Mann	ICAPST-2026-EAS-485078	Poster
Panchami P P	ICAPST-2026-EAS-528683	Poster
Dr. Vinita Sharma	ICAPST-2026-EAS-715787	Oral
Ashish Dev Kanwadia	ICAPST-2026-EAS-889697	Poster
Deepika	ICAPST-2026-EAS-918657	Poster
Kiran Dhill	ICAPST-2026-EPIS-350938	Poster
Mahesh Kumar	ICAPST-2026-EPIS-406446	Poster

Ashwani Walia	ICAPST-2026-NPHP-848676	Poster
Uma Papnoi	ICAPST-2026-NPHP-860297	Poster
Meemansa Yadav	ICAPST-2026-NPHP-900793	Poster
Deekshaa Meena	ICAPST-2026-NPHP-917785	Poster
Rajendra Prasad Meena	ICAPST-2026-NPHP-965468	Poster
Shilpa Kumari	ICAPST-2026-NPHP-976086	Poster
Hitesh Kumar	ICAPST-2026-EPIS-778277	Poster
Khemchand Saini	ICAPST-2026-EPIS-964334	Poster
Dr. Someshwar Pola	ICAPST-2026-EPIS-634772	Online

Track RSES

Full Name	Abstract ID	Presentation
Aastha Joshi	ICAPST-2026-RSES-441012	Oral
Bholu Ram Swami	ICAPST-2026-RSES-412805	Oral
Dr. Manoj K. Singh	ICAPST-2026-ESHT-614715	Oral
Dr. Namrata Sengar	ICAPST-2026-RSES-654126	Oral
Dr. Rahul Dev	ICAPST-2026-RSES-676573	Oral
Jyoti Yadav	ICAPST-2026-ESHT-223285	Oral
Koushal Shringi	ICAPST-2026-RSES-302044	Oral
Priyanka Meena	ICAPST-2026-ESHT-786128	Oral
Sandeep Kumar	ICAPST-2026-ESHT-832367	Oral
Vikhyat	ICAPST-2026-RSES-515668	Oral
Shreelahari D H	ICAPST-2026-ESHT-124613	Poster
Prerana B Vidyanjan	ICAPST-2026-ESHT-234398	Poster
Bhubesh Chander Joshi	ICAPST-2026-RSES-303607	Poster

Track ESHT

Full Name	Abstract ID	Presentation
Mamta Jha	ICAPST-2026-ESHT-347042	Poster
Dr. Saroj Rani	ICAPST-2026-ESHT-669126	Poster
Priyanka Madhukar	ICAPST-2026-RSES-100930	Poster
Vijay Ujjawal	ICAPST-2026-RSES-289696	Poster
Ajeet Kumar	ICAPST-2026-RSES-303607	Poster
Rishika Sharma	ICAPST-2026-RSES-524562	Poster
Deepmala Meena	ICAPST-2026-RSES-528114	Poster
Praful Chandrakant Mundake	ICAPST-2026-RSES-530930	Poster
Swapnil Santosh Tayade	ICAPST-2026-RSES-530930	Poster
Ravi Kumar Chopdar	ICAPST-2026-RSES-652539	Poster
Priyanka Lodha	ICAPST-2026-RSES-760719	Poster
Surendra Kumar Verma	ICAPST-2026-RSES-840780	Poster
Anamika Baranda	ICAPST-2026-RSES-996464	Poster
Sunaina	ICAPST-2026-RSES-350502	Online

INDEX

Plenary/Keynote/Invited Talks

SN	Abstract ID	Name	Talk Title	Page No.
1	PT-1	Prof. Avinash C Pandey	Advances in Physical Sciences and Technologies: In the light of Research Breakthroughts	1
2	PT-NPHP-7047	Prof. Amare Abebe	A Cosmological Consistency Triangle as a Model-Discrimination Framework	2
1	KT-ESHT-5950	Prof. Kedar Singh	Recent Advances of Low Dimensional Materials for Energy Storage Applications	3
2	KT-NPHP-7416	Dr. Maxime Gouzevitch	Quest for the Higgs boson: A Bridge Between the Big Bang and the Quantum World	4
3	KT-RSES-6201	Prof. K S Reddy	Solar Energy Technologies for Sustainable Development in Tropical Regions	5
1	IT-AMNS-1458	Dr. Harsh Soni	A Flock Through a Nematic Medium	6
2	IT-AMNS-2406	Dr. Kamlendra Awasthi	Flexible and Wearable Gas Sensors Based on Functional Nanomaterials	7
3	IT-AMNS-3204	Prof. Paolo Mele	Engineering Nanodefects in Thin Films for Superconducting and Thermoelectric Energy Technologies	8
4	IT-AMNS-3501	Dr. Komal Bapna	SI traceable Temperature and Humidity Sensors for Non-Invasive Human Health Monitoring	9
5	IT-AMNS-5508	Prof. Arun Pratap	Thermo-analytical techniques to investigate phase transformations and associated kinetic parameters	10
6	IT-AMNS-7148	Dr. Archana Tiwari	Green Synthesis of Fluorescent Carbon Quantum Dots from Madhuca longifolia for Selective Pb^{2+} Detection and EPR Investigation of Photoinduced Reactive Oxygen Species	11
7	IT-AMNS-7195	Prof. Sanjeev Kumar Sharma	CNT-Functionalized Metal Oxide Nanocomposites for Efficient Catalytic Removal of Aquatic Pollutants	12
8	IT-AMNS-8908	Dr. Chandra Shekhar Pati Tripathi	Recent Advances in Piezocatalysis: Emerging Applications for Sustainable Environmental Remediation	13
9	IT-EAS-3464	Dr. Purushottam Soni	Microfluidics on Earth and Beyond: Engineering Tools to Understand Biological Responses to Environmental Stressors	14

SN	Abstract ID	Name	Talk Title	Page No.
10	IT-EAS-4053	Prof. Neelima Gupta	Mechanistic Origins of Stereochemical Control in Thiazolium Ylide Chemistry: Computational Insights	15
11	IT-EAS-8610	Mr. Kartikey Gupta	Frost the Official Record Cannot See: Nocturnal Radiative Cooling at a Rural Campus versus Jaipur Airport, 2018–2026	16
12	IT-EPIS-2213	Prof. Devendra Kumar Mishra	Quantum metrology assisted quantum computing	17
13	IT-EPIS-4586	Dr. Jitendra Singh	Semiconductor MEMS and Microsystem Devices: Current Status and Future Perspectives	18
14	IT-EPIS-8499	Prof. Suman Rai	Upconversion, downconversion, and Quantum cutting studies of $Yb^{3+}Er^{3+}$/ Yb^{3+}/Ho^{3+} codoped in ZnS nanoparticles embedded silicate glass matrix	19
15	IT-EPIS-9901	Prof. Manish Dev Shrimali	From Data to Dynamics: Machine Learning for Complex Systems	20
16	IT-ESHT-3672	Prof. Thakur Prasad Yadav	Recent Advances and Emerging Opportunities in Hydrogen Production, Storage, and Utilization through Advanced Materials	21
17	IT-ESHT-4075	Dr. Subhradeep Mistry	Finding the Ideal Synthetic Conditions to Produce N-doped MOF-derived Materials for the HER From A New Co(II)-based Nitrogen Rich MOF	22
18	IT-ESHT-8221	Dr. Mohammed Saquib Khan	Advancing Lithium-Sulfur and Sodium-Sulfur Batteries through Sulfur Phase Engineering and Catalysis	23
19	IT-NPHP-1655	Prof. Subhashish Banerjee	Neutrino Oscillations and Quantum Information	24
20	IT-NPHP-2610	Dr. Krishnakumar Ravindran	Recent Results from BESIII experiment	25
21	IT-NPHP-3909	Dr. Ashish Kumar Meena	Extremely magnified stars at cosmological distances	26
22	IT-NPHP-5294	Dr. Rajnikant Makwana	The role of Nuclear Transport Codes for Advanced Nuclear Data Generation	27
23	IT-NPHP-5757	Dr. Harphool Kumawat	The Surrogate Method: Entering the Nucleus Through a Side Door	28
24	IT-NPHP-5806	Prof. Ajay Kumar Tyagi	Surrogacy vs Direct reaction: Pros and Cons	29
25	IT-RSES-1517	Prof. Ashmore Mawire	Thermal performance of a dual-purpose solar box cooker for simultaneous cooking and drying food with auxiliary heating	30
26	IT-RSES-3698	Prof. Maarten Vanierschot	The influence of turbulence modelling on heat and mass transfer characteristics in indirect solar dryers	31

SN	Abstract ID	Name	Talk Title	Page No.
27	IT-RSES-8846	Dr. Dilip Kumar Meena	Polymer-mixed Sb_2Te_3/Te nanocomposites exhibiting p-type to n-type conduction reversal and thermal conductivity reduction	32
28	IT-RSES-9042	Prof. Atul A. Sagade	Innovations in decentralized energy solutions: Opportunities in Latin America	33

Presentations

AMNS

Sr. No.	Abstract ID	Name of the Candidate	Title of the Abstract	Page No.
1	ICAPST-2026-AMNS-103980	Margi Solanki	Semiconductor Materials for Gamma-Ray Shielding Applications: A Review	34
2	ICAPST-2026-AMNS-105067	Suresh Kumawat	Structural, Morphological and Optical Properties of Sr substituted La_2CrMnO_6 Double Perovskite	35
3	ICAPST-2026-AMNS-108166	Sahil Singh	Structural, Morphological & Optical properties of Pr-doped $BaSnO_3$ perovskite	36
4	ICAPST-2026-AMNS-112684	Rahul Pilania	Impact of Li doping on structural, optical, and electronic properties of ZnO nanoparticles	37
5	ICAPST-2026-AMNS-114289	Ms. Manisha	Harnessing synergistic effects of SPM nanoferrites for bio-magnetic engineering	38
6	ICAPST-2026-AMNS-121912	Meghraj Saini	Antifertility Potential of Plants based Bioactive Nanoparticles: Advancement in Pharmacological and Biomedicinal Applications	39
7	ICAPST-2026-AMNS-125901	Manisha Bajpai	Plant-Mediated Green Synthesis of Silver Nanoparticles Using Graptopetalum macdougallii: Structural and Morphological Characterization	40
8	ICAPST-2026-AMNS-127867	Sarjana Yadav	Optimized Wavy Silver Nanorod Arrays for Advanced SERS Biosensing	41
9	ICAPST-2026-AMNS-133249	Anuradha Singh	Effect of Cu Doping on Structural, Optical, and Thermal Properties of ZnO/PEDOT: PSS Composite Thin Film	42
10	ICAPST-2026-AMNS-136043	Neha Chauhan	Fabrication of copper ferrite nanoparticle-modified electrode for selective dopamine detection	43
11	ICAPST-2026-AMNS-143558	Ajay Tripathi	Laser-Driven Phase Evolution and Morphology Control in High-Entropy Alloy Nanoparticles	44
12	ICAPST-2026-AMNS-157602	Nisha Rajput	Selective CO_2 Reduction to Methanol on $Ag5Cu_3$ Bimetallic Nanoclusters: A DFT Study	45
13	ICAPST-2026-AMNS-197538	Teena Meena	Plant-Assisted Green Synthesis of $NiFe_2O_4$ Nanoparticles Using Lemon Extract and Their Structural Properties	46
14	ICAPST-2026-AMNS-224099	Nupur Rana	$La_{0.05}NiFe_{1.95}O_4$/g-C_3N_4 Nanocomposites for Photocatalytic Degradation and Humidity Sensing Applications	47
15	ICAPST-2026-AMNS-227837	Laxman Prasad Gurjar	Study of Structural and Optical Properties of Pure and Ni-doped TiO_2 Nanoparticles	48
16	ICAPST-2026-AMNS-272922	Babli Kumari	Synthesis, Structural Characterization, and Potential Applications of Ni-Doped f/MWCNT Nanocomposites	49

17	ICAPST-2026-AMNS-287291	Shivani Deshwal	Structural, magnetic, electronic and thermoelectric properties of CrVTiAl quaternary Heusler compound using FP-LAPW method: A first-principles study	50
18	ICAPST-2026-AMNS-294974	Ashok Saini	Doping-Induced Defect and Surface Modulation in SnO_2 for Enhanced Gas Sensing Performance	51
19	ICAPST-2026-AMNS-312355	Bhanu Pratap Singh	Multi-Property Investigation of Unfilled Binary AB3 Skutterudites (A= Ir, Rh; B= P, As, Sb): Structural, Electronic, Optical, Thermal, and Thermoelectric	52
20	ICAPST-2026-AMNS-337530	Dr. Deepali	Study about the Innovations in Nanotechnology and Nanomaterial Design to Real-World Applications	53
21	ICAPST-2026-AMNS-340765	Neha	Green-Synthesized Cassia fistula Silver Nanoparticles Exhibit Reversible Antifertility Effects in Male Wistar Rats: A Plant-Based Male Contraceptive Approach	54
22	ICAPST-2026-AMNS-355969	Riyaz	Investigation of Microwave Absorption and Reflection Loss Behaviour of Epoxy-Embedded Barium Hexaferrite/Carbon Black Nanocomposites in the X-Band	55
23	ICAPST-2026-AMNS-364523	Anil Kumar	Development of Flexible Sheets of Zn^{2+}-Modified $BaFe_{12}O_{19}$/PU–PMMA Interpenetrating Polymer Network for Enhanced Magneto-Mechanical and Dielectric Properties	56
24	ICAPST-2026-AMNS-371616	Dr. Abhay Dasadia	Quantitative Evaluation of Residual Stress and Nitrogen-Related Defects in Single-Crystal Diamond	57
25	ICAPST-2026-AMNS-398944	Deepa Yadav	Structural and Optical Properties of Al-Doped SnO_2 Nanocrystalline Semiconductors	58
26	ICAPST-2026-AMNS-402213	Neeraj Kumar Singh	Unveiling Elastic and Thermoacoustic Properties of Gadolinium Monochalcogenides	59
27	ICAPST-2026-AMNS-414143	Chithra B	Tuning Bandgap and Bactericidal Efficiency in Ni^{2+} Substituted CuO Nanostructures: Structural and Optical Insights	60
28	ICAPST-2026-AMNS-421548	Neha Motwani	Structural, Morphological, Optical and Magnetic Properties of Sr-Doped La_2FeMnO_6 Double Perovskites	61
29	ICAPST-2026-AMNS-422050	Amit Kumar Meena	Structural, optical, morphological, electronic and magnetic properties of nanosized Dy-substituted cobalt ferrite synthesized by sol-gel auto-combustion method	62
30	ICAPST-2026-AMNS-428981	Chandra Prakash Barupal	Insights into the Electronic Structure and Magneto-Dielectric Behavior of Nickel-Substituted Cobalt Nanoferrite	63
31	ICAPST-2026-AMNS-445849	Nidhi Yadav	Performance and Optimization of SnS2/Cs2AgBiBr6/Spiro-OMeTAD Solar Cells: A SCAPS-1D Study	64
32	ICAPST-2026-AMNS-449143	Pashupati Pratap Neelratan	Ag-Doped ZnO: GO Thin Films as High-Performance CO_2 Gas Sensors	65

33	ICAPST-2026-AMNS-463678	Avinash Vyas	Quantum Oscillations and Electronic States of Cr_3Ge	66
34	ICAPST-2026-AMNS-474336	Damini Dahiya	Synergistic ROS Generation and Charge Transfer in Clitoria ternatea-Phytosynthesized Nd_2O_3/Chitosan Nanocomposites for Enhanced Visible-Light Photocatalytic Degradation	67
35	ICAPST-2026-AMNS-479570	Komal	Cu Substitution Effect on Structural, Morphological and Optical Properties of Sr_2FeMnO_6	68
36	ICAPST-2026-AMNS-488309	Dr. Vanarajsinh Solanki	Study of Ultra-sensitive GnP-TiO_2 composite Based NH_3 Sensor	69
37	ICAPST-2026-AMNS-502332	Devendra Kumar Mahawar	Computational Study on Selective H_2O_2 Synthesis via Two-Electron Oxygen Reduction on Functionalized Carbon Quantum Dots	70
38	ICAPST-2026-AMNS-506225	Dr. Ritu Saharan, Gopal Sharma	Converting Morus alba Leaf Waste into Flaxseed-Reinforced Eco-Friendly Biocomposites	71
39	ICAPST-2026-AMNS-508538	Balkar Singh, Dr Anup Thakur	Cr-Doped Sr–Zn Aluminate Phosphors: Toward Next Generation Solid-State Lighting	72
40	ICAPST-2026-AMNS-531201	Ram Naresh Meena	Study of Magnetic-Dielectric Correlation in Gd- Substituted Co-Cr Spinel Ferrite: Structural and Vibrational Insights. $CoCr_{0.5}Gd_xFe_{1.5-x}O_4$	73
41	ICAPST-2026-AMNS-543128	Pavithra N	β-Cyclodextrin Embedded MXene Sheets Based Electrochemical Assay for Quantification of Luteal Phase Hormone-Progesterone	74
42	ICAPST-2026-AMNS-545617	Prithvi Raj	Structural Characterization and Doping Strategy for Vanadium-Incorporated TiO_2 as a Dilute Magnetic Semiconductor	75
43	ICAPST-2026-AMNS-554799	Arshpreet Singh	Cu^{2+}-Mediated Tailoring of Gypsum-Based Biomimetic Material for Radiation and Biomedical Imaging	76
44	ICAPST-2026-AMNS-562927	Anshul Khandelwal	Lead-Free Halide Perovskites: Structure, Photophysical Properties, and Optoelectronic Applications	77
45	ICAPST-2026-AMNS-579001	Veenu Sisodia	Green synthesized ZnO nanoparticles for Antimicrobial applications and sustainable water remediation	78
46	ICAPST-2026-AMNS-581140	Chandra Prakash Barupal	Structural, Spectroscopic and Optical characterization of Gadolinium Substituted Mixed nanocrystalline Ferrite for technological uses	79
47	ICAPST-2026-AMNS-613707	Sandeep Kumawat	Mechanochemically Activated Synthesis of Nitrogen-Doped $SrTiO_3$ for Visible-Light Photocatalysis	80
48	ICAPST-2026-AMNS-620923	Hemanth B S	Unlocking the Morphological Influence on Optical Behaviour of Magnesium Oxide for Radiative Cooling Performance	81

49	ICAPST-2026-AMNS-623992	Ravila Meena	Design and Synthesis of A New Metal-Organic Frameworks (MOFs) For A One-Pot Tandem Deacetalization-Imine Condensation Reaction	82
50	ICAPST-2026-AMNS-676255	Sunita Kumari	Study of Structural Properties and Electronic Structure of Pure and Co-doped ZrO_2 Nanoparticles	83
51	ICAPST-2026-AMNS-713522	Ajai Krishnan	Defect-mediated dielectric relaxation and nanoscale magnetic domain evolution in Te-doped $BiFeO_3$ ceramics	84
52	ICAPST-2026-AMNS-719802	Malavika RK	A Paper-Based Label-Free Colorimetric Platform for Point-of-Care Detection of Vitamin C Using $CuCo_2O_4$/CuO Nanocomposites	85
53	ICAPST-2026-AMNS-736122	Ankit Kumar	Binder-Free In-Situ Hydrothermal Growth of NiO Thin Films on FTO Substrates for Smart Electrochromic Supercapacitor Electrodes	86
54	ICAPST-2026-AMNS-737750	Komal Sharma	First Principles Study of $CeOs_4As_{12}$ Filled Skutterudite	87
55	ICAPST-2026-AMNS-739561	Shubha Vats	Photocatalytic degradation of Methylene Blue dye using Cr_2O_3/MoS_2/PANI	88
56	ICAPST-2026-AMNS-745047	Cheshta	Structural Crystallinity, Functional Group Analysis and Optical Behaviour of $ZnFe_2O_4$ Ferrite Nanoparticles Prepared by Green Sol-Gel Method	89
57	ICAPST-2026-AMNS-779814	Shrikant Verma	High-Efficiency Lead-Free $CsSnI_3$ Perovskite Solar Cells Enabled by WS_2 and Cu_2O Selective Transport Layers	90
58	ICAPST-2026-AMNS-782731	Nithin Gowda B S	Development of an Electrochemical Biosensor Based on Fe–Ni MOF and Conducting Polymer Composites on Carbon Cloth for Early Cancer Biomarker Detection	91
59	ICAPST-2026-AMNS-785170	Dr. Rajni Bala	Influence of Na_2O on Lithium Bismuth Silicate Glasses: Structural and Physical Properties	92
60	ICAPST-2026-AMNS-800803	Rajneesh Kuldeep	From Biomolecular Building Blocks to Functional Bionanozymes: Enzyme-Mimetic Activity, Molecular Recognition, and Therapeutic Applications	93
61	ICAPST-2026-AMNS-801088	Ankur M Kumar	Design, Synthesis, Spectroscopic Characterization and DFT Calculations of Hybrid Dibutyltin (IV) Complexes of 4-Acyl Pyrazolone and Carboxylate Ligands	94
62	ICAPST-2026-AMNS-814596	Jay Sharma	In Vitro Growth-Driven Si/ZnO/HfO_2 Heterostructures for Enhanced Electron Mobility	95
63	ICAPST-2026-AMNS-817435	Surbhi Sharma	Solvothermal Synthesis and Defect Engineering of WO_3 Nanostructures for High Performance Supercapacitors	96
64	ICAPST-2026-AMNS-849471	Rajeev Dwivedi	Engineering Lead-Free Multiferroic Composites for Enhanced Magnetoelectric Performance: Roles of Composition and Sintering Conditions	97

65	ICAPST-2026-AMNS-870805	Elen Mary Shaju	Quercetin-Functionalized Coconut Shell-Derived Activated Carbon for Sensitive Electrochemical Detection of Dopamine Toward Early Parkinson's Disease Diagnosis	98
66	ICAPST-2026-AMNS-872489	Santosh Yadav	Influence of CdS Incorporation on Fractal Surface Morphology and Acetone Sensing of TiO_2 Thick Films	99
67	ICAPST-2026-AMNS-872796	Sharika Afreen	Synthesis-Route-Dependent Structural and Electrochemical Properties of Co3O4 Nanoparticles.	100
68	ICAPST-2026-AMNS-888373	Nitesh Sevakram Koche	Synthesis, structural, morphological and photoluminescence properties of ilmenite $CdSnO_3$ nanoparticles.	101
69	ICAPST-2026-AMNS-908655	Arun	A Comprehensive Review on Cellulose-MOF Based Functional Material as Waste Water Treatment	102
70	ICAPST-2026-AMNS-918784	Muskan	Green Sol-Gel Synthesis of Nanocrystalline $MgFe_2O_4$ Ferrite using Lemon Derived Citric Acid	103
71	ICAPST-2026-AMNS-925680	Shivaswamy M B	A bifunctional electrocatalyst based on f-CNT doped mesoporous PdCu3 nanocubes for Pb2+ monitoring and water splitting	104
72	ICAPST-2026-AMNS-939235	Bineesha C	Plectranthus amboinicus-modified ZnO nanoflorets for dual function water purification: A potent green catalyst for efficient dye degradation and antibacterial defense	105
73	ICAPST-2026-AMNS-993943	Manroop Singh, Ms. Manju	Mg-Al-Ga based double spinels: Cation ordering and luminescence study	106

EAS

Sr. No.	Abstract ID	Name of the Candidate	Title of the Abstract	Page No.
74	ICAPST-2026-EAS-121838	Hubertwell Thabah	Synthesis and Characterization of NPK-Loaded Cellulose-Based Hydrogel from Arecanut Husk and Its Effects on Soil Properties and Maize (Zea mays L.) Growth	107
75	ICAPST-2026-EAS-130162	Marshal Thabah	Defect Engineering and Interface Chemistry in Biohybrid Systems: Emerging Design Strategies for Advanced Environmental and Energy Applications	108
76	ICAPST-2026-EAS-155024	Dr. Piya Roychoudhury	Bioremediation of toxic dyes from water using iron oxide nanoparticles loaded lichen biomass	109
77	ICAPST-2026-EAS-159244	Jeevitha. N	Sustainable Carbon Quantum Dots for Climate-Resilient Agriculture: A Comprehensive Review	110
78	ICAPST-2026-EAS-169817	Harshitha P	Development of silver-graphene oxide for environmental applications	111
79	ICAPST-2026-EAS-244928	Manoj Tripathi	Multi-Response Optimization of Microwave Pyrolysis for Sustainable and Efficient Conversion of Orange Peel into Highly Porous Functional Carbon	112

80	ICAPST-2026-EAS-375452	Dr. Narendra Babu Simhachalam	Eco-Friendly Synthesis of TiO2@CeO_2 Core–Shell Heterostructures for Enhanced Visible-Light Photocatalytic Remediation of Organic Pollutants and Automobile Wastewater	113
81	ICAPST-2026-EAS-485078	Vidhi Mann	Optical Investigation of Dielectric and Plasmonic Core–Shell Nanoparticles for Light Management	114
82	ICAPST-2026-EAS-523588	Dr Hemlata Dharmashaktu	Statistical Investigation of Coronal Mass Ejection (CME) Properties Across Solar Cycles 23 and 24	115
83	ICAPST-2026-EAS-528683	Panchami P P	Assessment of heavy metal contamination in Kasargod, Kerala	116
84	ICAPST-2026-EAS-594454	Keerthi S	Functionalised biochar for sustainable carbon sequestration and improved soil health in support of plant growth	117
85	ICAPST-2026-EAS-715787	Dr. Vinita Sharma	Circular Economy Strategies for Sustainable Municipal Solid Waste Management: Challenges and Opportunities	118
86	ICAPST-2026-EAS-889697	Ashish Dev Kanwadia	Synthesis, characterization, and dual-function remediation performance of an activated carbon-polyaniline (ac-pani) nanocomposite for textile effluents	119
87	ICAPST-2026-EAS-904570	Kishore B	Valorization of Banana Plant Waste into a Cellulose-Based Hydrogel and Its Effects on Soil Properties	120
88	ICAPST-2026-EAS-918657	Deepika	Identification and Characterization of Microplastics in Sewage Sludge	121
89	ICAPST-2026-EAS-974086	Dr. Suman Garia	Comparative analysis of Elemental abundance ratios, Oxygen ion charge state ratio and Average ionic charge states in shock-ICME and non-shock-ICMEs and their geomagnetic impact for solar cycle 23	122

EPIS

Sr. No.	Abstract ID	Name of the Candidate	Title of the Abstract	Page No.
90	ICAPST-2026-EPIS-149001	Praveen Kumar Yadav	Beyond Sensitivity: Nonlinear Detection-Threshold and Fabrication-Tolerance Analysis of Palladium-Loaded One-Dimensional Photonic-Crystal Hydrogen Sensors	123
91	ICAPST-2026-EPIS-195154	Abdullahi Tanimu	Resonant-state expansion for non-relativistic wave equation in one dimension	124
92	ICAPST-2026-EPIS-350938	Kiran Dhill	Effect of Pressure on Electronic Properties of B1 and B2 Phases of BaO using DFT	125
93	ICAPST-2026-EPIS-402750	Dr. Abhijeet Singh	IoT-Enabled Smart Energy Management System for Sustainable Buildings: Toward AI-Integrated Renewable Energy Solutions.	126
94	ICAPST-2026-EPIS-406446	Mahesh Kumar	Bio-Inspired Self-Powered Optoelectronic Devices for Artificial Vision	127
95	ICAPST-2026-EPIS-530659	Shruti Jangir	Optical spectra of BP and GaP using linear response time-dependent density functional theory	128

96	ICAPST-2026-EPIS-634772	Dr. Someshwar Pola	High-Sensitivity and Flexible Organic Thin-Film Transistor (OTFT) Sensor Functionalized with BDTTTBA Ligand for Selective Detection of Pb^{2+} Ions	129
97	ICAPST-2026-EPIS-778277	Hitesh Kumar	A comparative study of Quantum noise handling techniques	130
98	ICAPST-2026-EPIS-820724	Sugar Singh Meena	Robust Continuous-Variable Multipartite Entanglement Using Arrays of Nonlinear Waveguides	131
99	ICAPST-2026-EPIS-846199	Suyog Munshi	LSTM-Forecast-Aided Predictive Actor-Critic Parameter Tuning (P-APT) for UAV Relay-Assisted FSO Links under an Extended Composite-Impairment Channel Model	132
100	ICAPST-2026-EPIS-964334	Khemchand Saini	Flexible and Conformal Antennas for Multi-Domain Wireless Applications: A Review	133

ESHT

Sr. No.	Abstract ID	Name of the Candidate	Title of the Abstract	Page No.
101	ICAPST-2026-ESHT-124613	Shreelahari D H	Synthesis and electrochemical investigation of a bi-metallic ferrite for aqueous sodium-ion coin cell application	134
102	ICAPST-2026-ESHT-223285	Jyoti Yadav	Two-Dimensional Material-Enabled Interface Engineering of WO3/MXene Heterostructures for Efficient Solar-to-Hydrogen Conversion	135
103	ICAPST-2026-ESHT-234398	Prerana B Vidyanjan	Electrolyte-Dependent Electrochemical Performance of Banana Peel-Derived Biochar Electrodes for Integrated Chemical Waste Filtration and Multi-Ion Energy Storage	136
104	ICAPST-2026-ESHT-308347	Akshita Jain	To Enhance Electrochemical Parameters of Supercapacitor Using Transition Metal Oxide (TMO) Based Electrode Material	137
105	ICAPST-2026-ESHT-347042	Mamta Jha	Structural and Morphological properties of Zr-MOF/Polystyrene Films	138
106	ICAPST-2026-ESHT-402757	Dr Pura Ram	Exploring the Energy Storage Capabilities of Biodegradable Kitchen Waste	139
107	ICAPST-2026-ESHT-614715	Dr. Manoj K. Singh	Electrochemical Studies of BFO/Graphene Composite Hybrid Supercapacitors Employing an Ionic-Liquid Gel Polymer Electrolyte	140
108	ICAPST-2026-ESHT-645369	Deepika Kumari	Investigation of Heat Storage Materials Using an Electric Back-up Solar Cooker	141
109	ICAPST-2026-ESHT-669126	Dr. Saroj Rani	Crystallization Kinetics and Relaxation Behavior of Bismuth based Glasses	142
110	ICAPST-2026-ESHT-786128	Priyanka Meena	Effect on Structural, Morphological, and Electrochemical Properties of Tin Doping on Cobalt Oxide Synthesized by Solvo-Combustion Method for Supercapacitor Applications	143
111	ICAPST-2026-ESHT-832367	Sandeep Kumar	Experimental Study of Building Integrated Solar Cooker With Storage	144

NPHP

Sr. No.	Abstract ID	Name of the Candidate	Title of the Abstract	Page No.
112	ICAPST-2026-NPHP-152814	Dr. Shabana Khan	CP asymmetries in semileptonic decays B → K*μ+μ- and Bs → K*μ+μ	145
113	ICAPST-2026-NPHP-167679	Anil Kumar Yadav	Exploring New Physics Effects in Λb → Λcℓν and Λb → Λνν̄ Decays within the Standard Model Effective Field Theory	146
114	ICAPST-2026-NPHP-205601	Manthan Singh Shekhawat	Mass-Radius Relation of White Dwarfs Using Chandrasekhar Theory	147
115	ICAPST-2026-NPHP-211250	Divyansh Vaishnav	Exploring Non-Standard Interactions in Neutrino Oscillations	148
116	ICAPST-2026-NPHP-217509	Patel Jinendra Rameshbhai	Electron-Impact Inelastic Cross Sections for $C_3H_8O_2$ Isomers	149
117	ICAPST-2026-NPHP-239179	Ram Kumar Meena	Neutron shielding investigation of polyethylene based composites with incorporation of Boron Carbide using Monte Carlo Simulation	150
118	ICAPST-2026-NPHP-323223	Kavin Dashora, Mayank Gairola	A systematic review of study of Agegraphic dark energy model in F(Q) v/s F(R,T) gravity	151
119	ICAPST-2026-NPHP-336717	Manisha Verma	Parametric Evaluation and Magneto-Stabilization of Thermal-Ponderomotive Filamentation in Moving Plasmas: A Fluid-Dynamical Study	152
120	ICAPST-2026-NPHP-338892	Mukesh Kumar, Mukta Saini	Dark and Bright envelope solitons in an unmagnetized dusty plasmas having two temperature Maxwellian electrons	153
121	ICAPST-2026-NPHP-378354	Garima Punetha	Magnetic Monopoles, Glueballs and Deconfinement in Finite-Temperature SU(3) QCD	154
122	ICAPST-2026-NPHP-393163	Karnawati	Quantum Simulation of an Anharmonic Oscillator Using Variational Quantum Eigensolver	155
123	ICAPST-2026-NPHP-399646	Manan	Exploring the Magnetic Field and Radius of Influence Around Black Holes	156
124	ICAPST-2026-NPHP-422929	Varsha KV	Fusion studies in $^{28}Si+^{128}Te$ reaction at energies around the Coulomb barrier	157
125	ICAPST-2026-NPHP-440105	Shyamalee Bora	Joule-Thomson Expansion and Photon Sphere Lyapunov Instability of Charged AdS Black Holes in f(R,T) Gravity with Nonlinear Electrodynamics	158
126	ICAPST-2026-NPHP-451512	Ritesh Pandey	Light Deflection and Greybody Bound Around a BTZ-ModMax Black Hole in Plasma Medium	159
127	ICAPST-2026-NPHP-529965	Kuldeep Singh	Bright and Dark Envelope Solitons in an Electron-Beam Plasma with Two-Temperature Electrons	160
128	ICAPST-2026-NPHP-608570	Priya Meena	Atmospheric Propagation and Plasma Control of Asymmetric Airy-Bessel Vortex Beams	161
129	ICAPST-2026-NPHP-630394	Lata Panwar	Recent Advances in Jet Substructure-based studies at Collider Experiments	162

130	ICAPST-2026-NPHP-694059	Vikram Itkan	Activity Prediction of Radioactive Source Thallium-204 using an Artificial Neural Network	163
131	ICAPST-2026-NPHP-760922	Dr. Supriya Devi	Time as a Relative State Function: A Unified Framework from B-series, Thermodynamics and Relativity	164
132	ICAPST-2026-NPHP-820959	Avitesh Agrawal	Systematic Study of Pre-scission Neutron Multiplicity for Near-Superheavy Nuclei	165
133	ICAPST-2026-NPHP-848676	Ashwani Walia	Probing Scalar-Mediated Self-Interacting Dark Matter through White Dwarf Capture and Thermal Evolution	166
134	ICAPST-2026-NPHP-860297	Uma Papnoi	Shadow and deflection angle of charged rotating black hole surrounded by perfect fluid dark matter	167
135	ICAPST-2026-NPHP-900793	Meemansa Yadav	Investigating the Impact of White Dwarf Composition on Light-Mediator Dark Matter Capture	168
136	ICAPST-2026-NPHP-902252	Ashna B	Study of fission dynamics in $^{30}si+^{182,184,186}$ W reactions populating isotopes of Ra	169
137	ICAPST-2026-NPHP-917785	Deekshaa Meena	Self- Focusing Of A Hermite Cosh Gaussian Beam In Plasma With Ripple Density In Relativistic and Ponderomotive Regime	170
138	ICAPST-2026-NPHP-930348	Dipankar Ray	Nonlinear Fluid Simulation of Jeans instability in Non-Maxwellian Magnetized Dusty Plasmas	171
139	ICAPST-2026-NPHP-965468	Rajendra prasad meena	Flat Top Solitary Waves in Dense Cold Ion Plasma with Relativistic Electron and Positron	172
140	ICAPST-2026-NPHP-976086	Shilpa Kumari	Symmetry Principles in Quantum Mechanics and Their Physical Implications	173

RSES

Sr. No.	Abstract ID	Name of the Candidate	Title of the Abstract	Page No.
141	ICAPST-2026-RSES-100930	Priyanka Madhukar	DFT Study of Heteroleptic Bis-diimine Cu(I) Complexes as Sensitizers for High-Performance Dye-Sensitized Solar Cells: Effects of Anchoring and Ancillary Ligand Modification	174
142	ICAPST-2026-RSES-289696	Vijay Ujjawal	Influence of Annealing Environment on the structural and optical properties of Sol-Gel Derived CZTS thin film	175
143	ICAPST-2026-RSES-302044	Koushal Shringi	Morphological and Elemental Characterization of Dust Deposited on Photovoltaic Modules Using SEM–EDS for Understanding Soiling-Induced Performance Degradation	176
144	ICAPST-2026-RSES-303607	Bhubesh Chander Joshi	Electron-Transport-Layer-Dependent Ionic Screening in Planar $MAPbI_3$ Solar Cells: Separating Electronic and Ionic Contributions	177
145	ICAPST-2026-RSES-350502	Sunaina	Numerical Simulation and Performance Optimization of Confined Lead-Free Planar Perovskite Solar Cells	178

146	ICAPST-2026-RSES-412805	Bholu Ram Swami	Optimizing Dual Absorber Layers for Above 30% Efficient Lead-Free 2D/3D Perovskite Solar Cells: A SCAPS-1D Modeling Approach	179
147	ICAPST-2026-RSES-441012	Aastha Joshi	Experimental Studies and Analysis of Drying of Bitter Neem Leaves (Azadirachta Indica) in Small-Size Portable Solar Dryer	180
148	ICAPST-2026-RSES-515668	Vikhyat	Metal-Organic Nanotube (MONT) as a Photocatalyst for the Visible-Light Driven Selective Dye Degradation	181
149	ICAPST-2026-RSES-524562	Rishika Sharma	Performance study of Passive Solar Still with mixing Commercial Coffee Powder	182
150	ICAPST-2026-RSES-528114	Deepmala Meena	Component-Wise Calculation of Heat Gain for Building Envelope and Suggestive Passive Cooling Measures for Enhanced Energy Efficiency	183
151	ICAPST-2026-RSES-530930	Praful Chandrakant Mundake, Swapnil Santosh Tayade	Comparative Study on the Photovoltaic Performance of SnO_2–CdS Nanostructured Solar Cells Fabricated by M-CBD and CBD Techniques	184
152	ICAPST-2026-RSES-652539	Ravi Kumar Chopdar	Modeling and Comparative Study of PV Panel Temperature and Energy Yield Under Control and Crop-Based Agrivoltaic Conditions	185
153	ICAPST-2026-RSES-654126	Dr. Namrata Sengar	Study of a Developed Small-Size Solar Water Heater for Cottage Textile Industry	186
152	ICAPST-2026-RSES-676573	Dr. Rahul Dev	Experimental Thermal Analysis of Photovoltaic Integrated Solar Chimney for Underpass Tunnel	187
155	ICAPST-2026-RSES-760719	Priyanka Lodha	Recent Advances in Heat Transfer and Storage Materials for Solar Power Systems	188
156	ICAPST-2026-RSES-840780	Surendra Kumar Verma	Investigation of a Flexible and Hierarchically Porous Polydimethylsiloxane Coating for Passive Daytime Radiative Cooling	189
157	ICAPST-2026-RSES-996464	Anamika Baranda	Effect of Annealing Temperature on the Structural and Optical Properties of Sol-Gel Derived Cu_2ZnSnS_4 (CZTS) Thin Films	190

Plenary Speakers

PT-01

Advances in Physical Sciences and Technologies: In the Light of Research Breakthroughs

From fundamental discoveries to transformative technologies, and the scientific frontiers of tomorrow

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The complexities inherent in scientific inquiry often surpass singular disciplinary boundaries, as emerging experimental evidence frequently challenges established frameworks that researchers rigorously uphold. This phenomenon underscores the notion of the universe "responding quietly" to humanity's assumption of absolute understanding. In this context, it is argued that adopting a non-absolutist perspective offers a solution to current epistemic polarization and divisive political climates, thereby suggesting the establishment of a "cognitive republic" that values humility and confronts contradictions rather than yielding to them.

A primary focus of this discourse is the ongoing pursuit of a "final theory of physics," commonly referred to as a Theory of Everything (ToE). This endeavor—a unified theoretical framework that aims to encapsulate all physical principles—remains contentious, with no consensus on its existence or feasibility.

From this dialogue, three critical lessons emerge: the fundamental role of measurement in the discovery process, the increasingly indistinct boundaries between disciplines such as physics, chemistry, biology, and computing, and the extensive time frame from scientific discovery to real-world application, which frequently spans decades. This process is illustrated through five interrelated stages: posing fundamental inquiries regarding nature, achieving scientific breakthroughs through theoretical and experimental means, developing enabling technologies, applying these innovations across diverse sectors, and generating new scientific inquiries based on such advancements. The process is inherently cyclical rather than linear, resembling a feedback loop.

Examples such as the transistor and the laser exemplify how these discoveries catalyze entire industries while concurrently serving as essential tools in fundamental research, affecting fields including attosecond science, gravitational waves, and quantum information. Furthermore, the quest to comprehend the origins and evolution of life illustrates how insights from one discipline can challenge long-held assumptions in another.

In conclusion, five key messages are articulated: the strategic importance of investment in fundamental research, the reciprocal reinforcement among various scientific fields, the critical necessity of measurement through advanced instruments, the distinction between recognition and scientific significance, and the imperative for India to cultivate the requisite talent, tools, and infrastructure to transform discoveries into national capabilities. The discussion concludes with reflective questions directed to the audience regarding unresolved mysteries, necessary advancements in measurement, and essential capabilities that must be developed in India prior to the occurrence of the next significant breakthrough.

PT-02

PT-NPHP-7047

A Cosmological Consistency Triangle as a Model-Discrimination Framework

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ABSTRACT

Cosmological tensions, particularly the H_0 and S_8 discrepancies, are increasingly best interpreted as tests of global mthe background expansion history, the present-day growth amplitude, and a theory-specific diagnostic determined by the model's irreducible deviation function, $F(z)$. I illustrate the framework using $f(Q)$ gravity and interacting dark energy models, demonstrating how the growth history, perturbation-level couplings, and $f\sigma_8(z)$ predictions provide complementary discriminants beyond background observables alone. The framework offers a unified perspective for assessing proposed resolutions to the H_0 and S_8 tensions and highlights implications for early and dynamical dark energy models in the era of next-generation cosmological surveys.

Keynote Speakers

KT-01

KT-ESHT-5950

Recent Advances of Low Dimensional Materials for Energy Storage Applications

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ABSTRACT

Low-dimensional materials like MXenes, 2D transition metal dichalcogenides (TMDCs) quantum dots and graphene are crucial for future energy storage due to their high surface area, excellent electrical conductivity and tunable properties. Tungsten disulfide (WS2) was synthesized via a solvothermal method and composited with reduced graphene oxide (rGO) to enhance its capacitive properties. The $(1\ T\text{-}WS2)_{90}(rGO)_{10}$ composite exhibited a specific capacitance of 230 F/g at 1 A/g in 1 M H_2SO_4, outperforming pristine 1 T-WS2 (171 F/g). Furthermore, the composite demonstrated excellent cycling stability, retaining 83.59 % of its initial capacitance after 10,000 cycles. These results highlight the potential of WS_2/rGO composites as high-performance electrode materials for supercapacitors.

$Ti_3C_2T_x$ MXene 2D sheets were prepared via acidic etching of precursor materials. $Ti_3C_2T_x$ MXene 2D sheets are treated through hydrothermal (water-based) and solvothermal (ethanol-based) approach at 150 °C to reduces the sheet size as well as producing $Ti_3C_2T_x$ MXene Quantum Dots. Galvanostatic charge-discharge (GCD) tests at current densities ranging from 1 to 5 Ag^{-1} revealed a significant improvement in the specific capacitance under all tested conditions. Similarly, CV at scan rates of 10–200 mVs^{-1} demonstrated an enhanced charge storage capability and superior rate performance, which was attributed to the synergistic effects of the MQDs. EIS confirmed the reduced charge-transfer resistance and excellent capacitive behavior across a wide frequency range. The enhancement in the results is due to the high surface area, remarkable electrical conductivity, and abundant electrochemically active sites of the MQDs.$Ti_3C_2T_x$ MQDs/nanohybrid composites based supercapacitors are providing a promising pathway for next-generation energy storage solutions with enhanced performance and durability.

Keywords: Low-dimensional materials; MXenes; 2D-transition metal dichalcogenides; Tungsten disulfide; Supercapacitors;

KT-02

KT-NPHP-7416

Quest for the Higgs boson: A Bridge Between the Big Bang and the Quantum World

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ABSTRACT

The Higgs boson is the result of a 50-year quest—from its prediction to its discovery at the Large Hadron Collider (LHC) in 2012. This extraordinary journey involved thousands of scientists across three generations, driven by a profound question: how do elementary particles acquire mass?

The Higgs mechanism makes the Weak interaction weak. We exist because of this effect: it controls proton-to-neutron conversion, allowing thermonuclear reactions in stars such as the Sun to proceed at the right rate, making the existence of stars—and ultimately life—possible.

Yet the discovery did not close the story. Is the Higgs mechanism the simplest possible explanation? How does it give mass to the lightest fermions—the electron and first-generation quarks forming ordinary matter? Could the Higgs connect us to the dark sector, whose nature remains unknown?

In the hot early Universe, particles were effectively massless. As the Universe cooled, the Higgs field acquired its present value through electroweak symmetry breaking—a critical moment in cosmic history. If this was a strong first-order phase transition, it could have contributed to the matter–antimatter asymmetry and left a gravitational-wave imprint. Its nature can be explored at the LHC, future colliders, and through gravitational-wave observations.

Keywords: *Higgs boson, Big bang, LHC, FCC, EWSB*

KT-03

KT-RSES-6201

Solar Energy Technologies for Sustainable Development in Tropical Regions

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ABSTRACT

Renewable energy-based decentralised energy systems are a viable approach to meet the basic energy needs of both rural and urban regions. This paper discusses and develops hybrid renewable energy technologies for large-scale urban and rural electrification. The main reason for choosing hybrid technologies is to overcome the inconsistency of power generation from conventional sources. Smart integration of different renewable technologies not only balances annual energy output but also complements them to reduce energy storage requirements and improve overall system efficiency. In recent years, research on integrating solar and biomass energy systems has gained attention, as it supports self-sufficient, sustainable rural electrification and helps local communities utilise bio-waste more effectively. High-temperature heat production for electricity generation often requires direct solar absorption. Solar thermal electric power systems promise to be the most cost-effective renewable energy systems to displace fossil fuels. Concentrating Solar Power (CSP) technology is among the front-runners in mainstream technologies developed so far. CSP plants are emerging as one of the most trusted technologies for transforming solar energy into electricity at scale. The solar parabolic dish with receiver configuration is often considered the most efficient system. To address intermittency in solar energy systems due to unforeseen weather conditions and improve dispatchability, the need for a Thermal Energy Storage (TES) system is becoming increasingly inevitable. It is undisputed that incorporating a TES system can substantially reduce the cost of concentrated solar thermal power plants by providing heat for extended durations, thereby increasing the plant's operational capacity and improving dispatchability. The present work is intended to investigate the TES thermocline system for CSP plants with different HTFs, namely therminol oil, Solar Salt and HITEC. Various HTFs are studied by taking discharge effectiveness as a pivotal parameter to analyse the influence of bed porosity, HTF, design and operating parameters. Because high-temperature operation improves CSP cycle efficiency, a detailed plant-level analysis with extended and seasonal thermal energy storage may show the extent of reliability improvement and cost-effectiveness.

Keywords: *Solar power, Thermal energy storage, CSP cycle efficiency*

Invited Talk

IT-AMNS-1458

A Flock Through a Nematic Medium

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ABSTRACT

We investigate the collective behaviour of motile rods immersed in a monolayer of apolar rods confined between vertically vibrating plates using numerical simulations. We uncover an antidiffusive instability whereby motile rods segregate from the apolar medium and form flocks whose size increases with the medium concentration. Remarkably, enhanced segregation leads to a reduction of the global polar order. The flock structure is strongly influenced by the anisotropy of the medium rods. For small aspect ratios, the flocks are elongated perpendicular to the mean direction of motion, whereas for larger aspect ratios, they elongate along the direction of motility. We rationalise the emergence of segregation-induced disorder using a minimal mean-field model.

Keywords: *Nematic materials, Active Matter, Soft matter, Flocking*

IT-AMNS-2406

Flexible and Wearable Gas Sensors Based on Functional Nanomaterials

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ABSTRACT

The growing demand for portable, low-power, and conformable sensing platforms has driven significant research interest in flexible gas sensors for environmental monitoring, healthcare diagnostics, and industrial safety applications. Unlike conventional rigid sensor architectures, flexible gas sensors fabricated on polymeric or textile substrates offer mechanical robustness, wearability, and the ability to conform to irregular surfaces, making them attractive for next-generation wearable electronics. This talk presents recent advances from our laboratory in the design, synthesis, and fabrication of nanostructured metal oxide, carbon-based, and hybrid nanocomposite materials integrated onto flexible substrates for selective and sensitive detection of target gases and volatile organic compounds (VOCs). Key challenges addressed include improving mechanical durability under repeated bending and stretching, achieving room-temperature operation, enhancing selectivity through surface functionalization, and ensuring long-term stability under ambient conditions.

Keywords: *Flexible gas sensors, Flexible substrates, Gas sensors*

IT-AMNS-3204

Engineering Nanodefects in Thin Films for Superconducting and Thermoelectric Energy Technologies

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ABSTRACT

Advanced energy systems require materials that transport current with minimal loss and convert waste heat into electricity. This work demonstrates how deliberately introduced nanodefects turn nanostructured thin films into high-performance energy materials, focusing on high-temperature superconductors and oxide thermoelectrics. In $YBa_2Cu_3O_x$ coated conductors (T_c = 92 K), artificial pinning centers immobilized magnetic vortices. One-dimensional $BaSnO_3$ nanorods yielded J_c = 0.3 MA cm^{-2} and $F_{p,max}$ = 28.3 GN m^{-3} at 77 K and 3 T, exceeding Nb_3Sn. Three-dimensional Y_2O_3 nanoparticles produced more isotropic pinning with $F_{p,max}$ = 14.3 GN m^{-3}, whereas combined 1D/3D multilayers reached 17.6 GN m^{-3}. In thermoelectric films, nanoscale architectures reduced thermal conductivity while preserving electrical transport. Hydroquinone/AZO reached k = 3.56 W m^{-1} K^{-1}; MAPLE-PLD PMMA-AZO achieved k = 5.9 W m^{-1} K^{-1} and ZT = 0.07 at 600 K; nanoporous Mist-CVD AZO gave k = 0.60 W m^{-1} K^{-1} and ZT = 0.06 at 300 K; and PLD Al_2O_3-AZO reached k = 3.98 W m^{-1} K^{-1} and ZT = 0.0007 at 600 K. Compared with bulk AZO, these structures lowered thermal conductivity by 10-100 times and increased ZT three- to fivefold, demonstrating nanodefect engineering as a versatile strategy for sustainable energy technologies.

Keywords: *Nanodefect Engineering, Thin Films, Superconductors, Thermoelectrics, Sustainable Energy*

IT-AMNS-3501

SI traceable Temperature and Humidity Sensors for Non-Invasive Human Health Monitoring

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ABSTRACT

Non-invasive and rapid health-monitoring technologies are gaining increasing importance for early detection and continuous assessment of human health. Temperature and humidity are two important physical parameters that can provide valuable physiological information without direct contact with the body. In particular, the humidity variations associated with human respiration contain information related to respiratory rate and respiratory health, while body-temperature measurements are widely used for monitoring physiological conditions.

This talk presents an overview of SI-traceable temperature and humidity measurement technologies for non-invasive human health monitoring, with emphasis on humidity sensors, infrared (IR) thermometers, and thermal imaging systems. The potential of humidity sensors for breath monitoring is discussed, including their response to variations in exhaled moisture and their applications in identifying respiratory abnormalities. Recent developments in sustainable and flexible humidity-sensing materials, including cellulose-based materials derived from biowaste, are also highlighted.

The talk further addresses contactless temperature measurement using IR thermometers and thermal imagers, including their measurement principles, calibration, performance evaluation, and the importance of metrological traceability. IR Thermometers and Thermal Imagers have been widely used in COVID-19 to measure the body temperature in a non-contact manner. The role of calibration facilities, reference standards, measurement uncertainty, and relevant international standards in establishing reliable and SI-traceable measurements for these devices is discussed.

Keywords: *SI traceable, Non-invasive health monitoring, IR sensors, Humidity sensors*

IT-AMNS-5508

Thermo-analytical techniques to investigate phase transformations and associated kinetic parameters

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ABSTRACT

Thermal measurements using thermoanalytical techniques investigate the kinetics of phase transformations and reactions. These measurements involve the response of different types of materials subjected to thermal stress. The responses are in terms of endothermic and exothermic reactions exhibiting heat flow, change of mass, dimensional change, etc

The thermoanalytical instruments are named Differential Scanning Calorimetry (DSC), Thermo-gravimetric Analyzer (TGA), Thermo-mechanical analyzer (TMA), Dynamic mechanical analyzer (DMA), and so on. Thermodynamic parameters such as heat of enthalpy and heat of melting are directly derived from the DSC thermogram. Exothermic events like crystallization, oxidation, and endothermic reactions like glass transition and melting are exhibited in the outputs of instruments like DSC. Further, kinetic parameters such as activation energy and pre-exponential factor (or frequency factor) are obtained using isokinetic and isoconversional methods.

Keywords: Differential Scanning Calorimetry, Thermogravimetric Analyser, Thermo-mechanical analyzer

IT-AMNS-7148

Green Synthesis of Fluorescent Carbon Quantum Dots from *Madhuca longifolia* for Selective Pb^{2+} Detection and EPR Investigation of Photoinduced Reactive Oxygen Species

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ABSTRACT

In this work, the first rapid green synthesis of blue-emitting carbon quantum dots (CQDs) from *Madhuca longifolia* (ML) leaves and their application in Pb^{2+} sensing and removal is presented. Fresh-leaf CQDs (F-CQDs) demonstrated selective fluorescence quenching toward Pb^{2+} with a detection limit of 7.8 nM, despite a moderate quantum yield of 3%, outperforming dried-leaf CQDs (2% yield). Adsorption studies revealed that Pb^{2+} removal follows pseudo-first-order kinetics and fits the Langmuir isotherm, indicating monolayer physical adsorption. Electron paramagnetic resonance spectroscopy confirmed UV-induced reactive oxygen species (ROS) generation ($g = 2.003$), with ROS-mediated photodegradation following biexponential decay due to surface defects and photochemical transformations. These findings establish ML-derived CQDs as promising, cost-effective sensors for Pb^{2+} while highlighting the need for enhanced photostability in real-world environmental applications.

Keywords: *Electron paramagnetic resonance, Carbon quantum dots, Green synthesis, PL sensor*

IT-AMNS-7195

CNT-Functionalized Metal Oxide Nanocomposites for Efficient Catalytic Removal of Aquatic Pollutants

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ABSTRACT

The increasing occurrence of pharmaceutical residues and synthetic dyes in water has become a major challenge for maintaining clean and safe aquatic environments. Conventional treatment methods often struggle to remove these chemically persistent contaminants efficiently, highlighting the need for effective and sustainable photocatalytic systems. In this context, CNT-functionalized metal oxide (CNT-MOx) nanomaterials, including CNT-TiO_2, CNT-ZnO, Gr-TiO_2, and CNT-CeO_2, have emerged as promising photocatalysts owing to their improved light utilization, tunable structural properties, and enhanced charge-transfer characteristics. A CNT-functionalized TiO_2-CeO_2 nanocomposite prepared by a hydrothermal method and tested for the simultaneous removal of ciprofloxacin and common dyes, including methylene blue, methyl orange, and rhodamine B, showed excellent photocatalytic performance, achieving ~99% degradation under solar irradiation. This enhanced activity is attributed to the synergistic coupling of TiO_2-CeO_2 with the conductive CNT network, which extends visible-light absorption and provides a high surface area of 68.19 m^2g^{-1}. The CNT-based conductive pathways further facilitate charge separation and suppress electron-hole recombination, promoting the formation of reactive oxygen species (•OH, $•O_2^-$, and h^+) that drive rapid pollutant degradation and mineralization. Overall, this CNT-metal oxide nanocomposite represents an eco-friendly, stable, and energy-efficient platform for the photocatalytic remediation of complex wastewater.

Keywords: *Photocatalyst; Reactive oxygen species; Charge separation; Wastewater treatment; Environmental remediation*

IT-AMNS-8908

Recent Advances in Piezocatalysis: Emerging Applications for Sustainable Environmental Remediation

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ABSTRACT

Piezocatalysis is an emerging catalytic process that converts mechanical energy into chemical energy through the piezoelectric effect. It enables pollutant degradation without requiring additional energy input when piezoelectric materials are exposed to mechanical force. Recent advances in material engineering have significantly improved the performance of piezocatalysts such as $BaTiO_3$, $NaNbO_3$, ZnO, $SrTiO_3$, PVDF-based composites, and their heterostructures. Combining piezoelectric materials with semiconductors, conductive polymers, MXenes, metal-organic frameworks, and porous polymers further enhances catalytic activity by improving charge separation and transfer. Tribo-piezocatalytic systems, piezo-photocatalytic heterojunctions, flexible PVDF composites, and hydrogels have shown excellent potential for environmental remediation. These materials efficiently degrade organic dyes, pharmaceuticals, and antibiotics, while also reducing heavy metal ions. They also exhibit good stability and reusability. Improved understanding of piezoelectric polarization, interfacial charge transfer, and reactive oxygen species generation has helped explain the piezocatalytic mechanism and guide catalyst design. Despite these advances, challenges remain in large-scale production, durability, mechanistic understanding, and practical application. Future progress in multifunctional materials and catalyst design is expected to further advance piezocatalysis.

Keywords: *Piezocatalysis, $BaTiO_3$, $NaNbO_3$, PVDF, Heterojunctions, Environmental remediation*

IT-EAS-3464

Microfluidics on Earth and Beyond: Engineering Tools to Understand Biological Responses to Environmental Stressors

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ABSTRACT

Living systems constantly interact with their surrounding environment, and changes in chemical exposures or physical conditions can influence biological function and health. Understanding these responses is important for addressing environmental health concerns on Earth and for sustaining human life during future exploration beyond Earth. *Caenorhabditis elegans* provides a powerful model for these studies because of its small size, short lifecycle, conserved biological pathways, and ability to generate statistically powerful datasets within a small experimental footprint. Microfluidics further enables precise control of the organism's microenvironment while providing quantitative measurements of biological responses. On Earth, we developed passive microfluidic well plates for scalable toxicology studies under controlled chemical exposures and NemaFlex for quantitative measurement of muscle strength. These technologies were subsequently translated and adapted for spaceflight. NemaFlex was modified and integrated with specialized containment and fluid-handling hardware for operation aboard the International Space Station, enabling measurement of spaceflight-induced functional decline. Similarly, the passive microfluidic devices were incorporated into sealed BioCells to meet spaceflight containment requirements. Together, these studies demonstrate how microfluidics can connect environmental health research on Earth with biological investigations in space and support future long-duration human space exploration.

Keywords: *Microfluidics, Environmental Health, Spaceflight, C. elegans, Environmental Toxicology, Microgravity*

IT-EAS-4053

Mechanistic Origins of Stereochemical Control in Thiazolium Ylide Chemistry: Computational Insights

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ABSTRACT

Computational chemistry has become an invaluable tool for elucidating reaction mechanisms, offering the ability to identify stabilized intermediates and locate transition structures along competing pathways, insights often difficult to obtain through experiment alone. Combined with experimental data, this approach provides a powerful means of rationalizing observed outcomes and understanding how reaction conditions influence product distribution. Thiazole scaffolds constitute an important class of heterocycles with wide-ranging biological and pharmacological activity, including antibacterial, antimalarial, anticancer, antiallergic, anti-inflammatory, and anti-HIV properties, making N-fused thiazole frameworks a compelling target for synthesis. Among strategies available, the 1,3-dipolar [3+2] cycloaddition of cyclic nitrogen ylides has emerged as a powerful approach for constructing N-fused five-membered heterocycles bearing a bridgehead nitrogen atom, valued for the inherent regio- and stereoselectivity these reactions afford in generating structurally complex architectures. Thiazolium ylides, owing to their distinctive electronic structure and reactivity, have attracted considerable attention in cycloaddition chemistry. However, their participation in [3+2] cycloadditions often leads to diverse and sometimes unexpected outcomes. Notably, depending on the reaction conditions, these cycloadditions frequently proceed further through ring opening, giving rise to notable downstream products. The mechanistic details of these competing pathways, cycloaddition, ring opening, and rearrangement driven by nucleophilic addition of the dipolarophile, have been investigated across different molar ratios through a combined experimental and computational approach, providing valuable insight into how reaction conditions govern product distribution. Together, these findings offer a comprehensive mechanistic rationale for the experimentally observed outcomes and underscore how computational chemistry, by identifying intermediate stabilization and mapping transition structures along competing pathways, can clarify reaction progress under different conditions and help explain experimental results in heterocyclic synthesis.

Keywords: *DFT Calculations, Computational Mechanistic Studies Thiazolium Ylides, N-Fused Heterocycles, Ring-opening Rearrangement.*

IT-EAS-8610

Frost the Official Record Cannot See: Nocturnal Radiative Cooling at a Rural Campus versus Jaipur Airport, 2018–2026

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ABSTRACT

Clear, calm winter nights in semi-arid Rajasthan let the ground shed heat rapidly as long-wave radiation, yet Jaipur's official reference thermometer stands at the airport on the city's edge. Eight years (2018–2026) of daily temperature extremes from an automatic weather station on the rural Vatsalya campus, 40 km north-north-east of the airport, were set against the airport's routine observations. A documented quality-control chain, cross-checked with the instrument's internal logger, yielded 2,312 matched nights. During November–February the airport's night minimum was on average 9.0 °C higher, while daytime maxima differed by less than 1 °C, so the rural diurnal range averaged 22 °C against 12 °C. The campus reached 0 °C or lower on 203 nights spread across all eight winters; the airport never did. The night-time contrast decayed with wind speed U as $U^{-1/2}$, from 10.5 °C in calm conditions to 6.9 °C in the windiest, and shrank by more than 40% on rainy days, as expected of a radiatively driven nocturnal boundary layer rather than an instrument offset. We discuss the physics, the implications for frost advisories and solar-energy use, and a low-cost rural observing network.

Keywords: *Radiative Cooling, Frost, Nocturnal Boundary Layer, Urban Heat Island, Station Representativeness, Citizen Weather Station*

IT-EPIS-2213

Quantum metrology assisted quantum computing

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ABSTRACT

The noisy intermediate-scale quantum (NISQ) era is defined by imperfect qubits/qumodes and operations, making precise device characterization a critical bottleneck. In this context, moving beyond single-parameter estimation is essential, as quantum processors are governed by multiple parameters simultaneously. This multiparameter approach, however, confronts fundamental challenges: incompatibility, where the optimal measurement for one parameter may not commute with the others, and sloppiness, where a model is sensitive only to certain parameter combinations. A central, unresolved question in this landscape is the choice between joint and separate estimation strategies. The is highly non-trivial and system-dependent strategy, with current NISQ devices, lacking a clear comparative analysis. We will discuss about the best exploitation of quantum resources to surpass classical precision limits as a benchmark of next-generation quantum hardware.

Keywords: *Quantum Metrology, Quantum Estimation Theory, Quantum Communication, Quantum Computing, Open Quantum Systems.*

IT-EPIS-4586

Semiconductor MEMS and Microsystem Devices: Current Status and Future Perspectives

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ABSTRACT

Tunable piezoelectric MEMS resonators make microwave transceivers adaptable to multiple bands of operation using a single filter, which is highly desirable in today's communication systems with a growing number of wireless applications. Acoustic wave devices offer key advantages, such as small size, lightweight, low power consumption, and the ability to integrate with integrated circuits (ICs), making them promising candidates for future 6G technology. Tunable filters can serve as alternatives to switching between several filters by incorporating tuning elements into a filter topology, allowing for more than one filter response. The size of RF/microwave systems, such as cellular radios or mobile phones, is continuously decreasing due to competitive market demands. Therefore, the goal is to achieve small, high-performance, and low-cost reconfigurable microwave integrated devices. Multiple frequency operations are possible with a single tunable microwave resonator. Currently, acoustic wave resonators are available for fixed frequencies of operation. Recent advancements in microwave communication systems indicate that these systems need to be more user-friendly, adaptable, and reconfigurable. The increasing number of channels and bandwidths requires agility in their performance. New functionalities are essential for devices to provide superior performance, making them frequency-agile and cost-effective. Reconfigurable bulk acoustic wave-based filters are attractive due to their tunability, multi-band frequency operation, and high-frequency performance. Zinc oxide (ZnO) is a promising candidate for acoustic wave resonators because of its high electro-mechanical coupling coefficient. Furthermore, zinc oxide is a versatile material that exhibits key physical properties, including piezoelectric, semiconducting, and optoelectronic characteristics, which are beneficial for various potential applications. Tuning materials such as Barium Strontium Titanate (BST) and magnetostrictive elements have also been integrated into acoustic wave resonators to enhance tuning functionality and enable multi-band frequency operation.

Keywords: *Piezoelectric MEMS resonators, Acoustic wave resonators, integrated circuits*

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IT-EPIS-8499

Upconversion, downconversion, and Quantum cutting studies of $Yb^{3+}Er^{3+}$/ Yb^{3+}/Ho^{3+} codoped in ZnS nanoparticles embedded silicate glass matrix

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ABSTRACT

This study investigates the effect of upconversion and Quantum cutting for manipulation of the solar spectrum. We aim to develop a multifunctional material that integrates upconversion and Quantum Cutting into one material to generate dual-mode emission. To this end, we have prepared a pair of triply ionized Yb/Ho and Yb/Er codoped with ZnS nanoparticles using the sol-gel technique. The structural properties of the prepared materials were characterized by XRD, TEM, and FTIR, and the optical properties by Absorption, Photoluminescence, upconversion, and quantum cutting, recorded in the visible and NIR regions at different excitation wavelengths of diode lasers. The results indicate that these glass materials have potential applications in photonic devices such as optical amplifiers and display devices, and for manipulating the solar spectrum via upconversion and Quantum cutting to increase the absorption efficiency of currently used C-Si solar cells. The CIE chromaticity analysis demonstrated that ZnS concentration can be used to tune the emission characteristics of the glass ceramics. Overall, the simultaneous observation of upconversion and quantum-cutting NIR emission in these glasses demonstrates that ZnS concentration is an effective means of tailoring their spectral response and emission color.

Keywords: Upconversion, Quantum cutting, ZnS nanoparticles, C-Si solar cells

IT-EPIS-9901

From Data to Dynamics: Machine Learning for Complex Systems

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ABSTRACT

Many of the world's most important phenomena—from weather and ecosystems to power grids, neural networks, and financial markets—are governed by complex systems. Their nonlinear interactions often give rise to chaos, sudden transitions, and emergent collective behavior. The inherent complexity of these systems makes accurate prediction and control challenging. Machine learning is a computational framework that enables computers to perform intelligent tasks by learning patterns from data generated by complex systems. Reservoir Computing (RC) is a machine learning framework that harnesses the dynamics of a physical or computational dynamical system to process and analyze data, rather than relying on conventional computing architectures.

This talk will introduce the fundamental ideas behind reservoir computing and physics-informed machine learning, illustrating how they bridge data-driven intelligence with the principles of dynamical systems. Through engaging examples, we will demonstrate how these methods can forecast chaotic dynamics, identify bifurcations and critical transitions, predict synchronization and tipping phenomena in complex networks, and enable adaptive control of nonlinear systems. The discussion will highlight how combining physics with machine learning is opening new frontiers in understanding, predicting, and controlling complex systems across science and engineering.

Keywords: *Machine learning, Reservoir computing, Physics-informed machine learning, Complex systems, Chaos, Critical transitions.*

IT-ESHT-3672

Recent Advances and Emerging Opportunities in Hydrogen Production, Storage, and Utilization through Advanced Materials

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ABSTRACT

The world is facing an energy crisis due to the depletion and limited availability of fossil-fuel resources. This situation necessitates urgent attention to both energy availability and the growing global demand for energy through the development and utilization of more efficient, clean, and sustainable alternative energy sources. Owing to their remarkable properties and relatively simple synthesis, nanomaterials including nanoparticles, nanotubes, and two-dimensional (2D) materials have emerged as some of the most important advanced materials and hold significant potential for applications in energy generation and storage. Hydrogen energy has been identified as a promising clean, sustainable, and high-energy-density energy carrier. The transport sector currently accounts for approximately 25% of global energy demand and contributes nearly 20% of global greenhouse-gas emissions. In automobiles, hydrogen can be utilized either as a fuel in fuel-cell vehicles or as a fuel in internal-combustion engines. In both cases, efficient and safe hydrogen storage remains a critical challenge. Key hydrogenation properties, including operating temperature, hydrogen plateau pressure, and storage capacity, vary considerably among different classes of hydrogen-storage materials. At present, no single hydrogen-storage material simultaneously satisfies all the requirements for practical vehicular applications. Quasicrystals, owing to their complex structures and unique physical and chemical properties, can also serve as promising catalysts for hydrogen-related applications. In this work, we developed a model catalyst consisting of a two-dimensional layer of nanoparticles formed on quasicrystalline surfaces through a controlled leaching approach. High-symmetry surfaces of single-grain icosahedral (i)-Al-Cu-Fe and decagonal (d)-Al-Ni-Co and d-Al-Cu-Co quasicrystals, as well as polycrystalline i-Al-Pd-Re, i-Al-Cu-Fe, and i-Al-Pd-Mn quasicrystals with randomly oriented surfaces, were leached in NaOH solutions for different durations. No distinctive microstructure was observed on the tenfold surface of d-Al-Ni-Co or on the polycrystalline i-Al-Pd-Re surface. After polishing the leached layers, the original quasicrystalline surfaces were restored, indicating that the leaching process was confined to a shallow region near the surface. The as-grown and mechanically activated leached quasicrystal layers were subsequently employed as catalysts in MgH_2-based hydrogen-storage systems. The catalytic effects of the leached high-entropy alloy layers on the dehydrogenation and rehydrogenation kinetics and overall hydrogen-storage properties of MgH_2 will also be discussed.

Keywords: *Hydrogen Energy; Hydrogen Production; Hydrogen Storage; Quasicrystal; High Entropy Alloys.*

IT-ESHT-4075

Finding the Ideal Synthetic Conditions to Produce N-doped MOF-derived Materials for the HER From A New Co(II)-based Nitrogen Rich MOF

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ABSTRACT

Human energy consumption is rising steadily with population growth. The majority of this energy is produced using fossil fuels, which has a severe negative impact on the environment. Hydrogen gas has emerged as a viable, greener alternative in recent years, produced via an electrocatalytic process that avoids the generation of harmful gases. Metal-organic frameworks (MOFs) have recently been explored as sacrificial agents to produce active electrocatalysts. The advantages of employing MOFs as sacrificial agents include their high porosity and functional nature. A simple pyrolysis of pristine MOFs can produce a carbonaceous nano-heterostructure without doping. However, a systematic study exploring the optimal conditions for synthesising carbon materials doped with heteroatoms such as N, S, B, and P is rare.

Here, the results will be presented for a nitrogen-rich Cobalt(II)-based MOF that was pyrolysed at different temperatures (600/800) under air and an Ar/H_2 gas mixture to generate N-doped carbonaceous Co_3O_4 or Co nanomaterials. Among them, the Co-metal-based nanomaterial produced at 800 °C under an Ar/H2 gas flow exhibits the lowest overpotential, 111 mV (j10). This superior performance was attributed to the presence of M–N–H_x species, which facilitate HER kinetics. Moreover, this catalyst exhibits high stability even after 400 hours of prolonged use.

Keywords: *Green energy, Hydrogen evolution, Electrocatalysis, MOF-derived nanomaterials, Nitrogen-doped carbon*

IT-ESHT-8221

Advancing Lithium-Sulfur and Sodium-Sulfur Batteries through Sulfur Phase Engineering and Catalysis

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ABSTRACT

Sulfur-based batteries offer potential for high-capacity energy storage, but their advancement depends on overcoming challenges associated with polysulfide dissolution, electrolyte compatibility, and sluggish reaction kinetics. Addressing these limitations requires a deeper understanding of how sulfur chemistry, carbon architectures, and catalytic interfaces govern electrochemical behaviour. This work explores two complementary strategies for improving lithium-sulfur and sodium-sulfur batteries: sulfur phase engineering and catalytic modification. The first approach examines monoclinic sulfur supported on activated, electrospun carbon fiber mats, highlighting its role in enabling direct sulfur conversion and stable cycling in carbonate electrolytes. The study examines how carbon activation improves sulfur loading and supports cathode performance without relying on sulfur confinement. The second approach considers ruthenium dioxide as a catalytic modifier for sulfurized polyacrylonitrile cathodes in sodium-sulfur batteries, demonstrating how catalytic modification can alleviate kinetic limitations and improve reaction reversibility. Drawing on these studies, the discussion connects cathode structure and chemistry with charge transfer, rate capability, and cycling stability. The investigation emphasizes the complementary roles of controlling sulfur reaction pathways and facilitating conversion kinetics, offering broader design principles for sulfur-based cathodes. These insights provide a foundation for developing durable, efficient energy storage systems while identifying considerations for translating material-level advances toward practical battery applications.

Keywords: *Catalyst, Ruthenium oxide, Sodium-sulfur battery, Sulfurized polyacrylonitrile*

IT-NPHP-1655

Neutrino Oscillations and Quantum Information

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ABSTRACT

Quantum correlations are a central topic of investigations in the quest for an understanding as well as for the harvesting of the power of quantum mechanics in a plethora of systems provided by nature. Here, this quest is directed towards neutrino oscillations. Various facets of quantum correlations, for example, entanglement, are discussed in the context of neutrino two- and three-flavour oscillations. Further, the Leggett-Garg inequalities are illustrated using the length scales and energies of ongoing long-baseline accelerator neutrino experiments such as T2K, NOvA, and the upcoming DUNE experiment. The neutrino oscillations in matter are also probed via the Quantum Speed Limit (QSL).

Keywords: *Neutrino Oscillations, Leggett-Garg inequalities, Quantum Speed Limit (QSL)*

IT-NPHP-2610

Recent Results from BESIII experiment

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ABSTRACT

The BESIII experiment at the Beijing Electron–Positron Collider (BEPCII) is a multipurpose experiment operating at the τ–charm energy frontier. The clean (e^+e^-) environment and exceptionally large samples of charmonium and open-charm events provide a unique laboratory for investigating non-perturbative QCD, flavor physics, quantum mechanics and physics beyond the Standard Model.

A highlight of the recent BESIII program is the study of the (X(2370)). Combining measurements of its mass, ($J^{PC} = 0^{-+}$) quantum numbers, production and decay properties, and the suppression of ($K^*\bar{K}$) decays, BESIII finds that a dominant pseudoscalar-glueball component provides a natural interpretation of this state, offering an important experimental window into gluonic excitations of QCD.

BESIII has also exploited entangled hyperon–antihyperon pairs to perform precision tests of CP symmetry and quantum nonlocality. Recent measurements further probe sub-GeV dark-sector interactions, demonstrating sensitivity to physics beyond the Standard Model.

This talk will highlight these recent results and illustrate how the τ-charm frontier provides complementary access to strong-interaction dynamics, fundamental symmetries and new physics.

IT-NPHP-3909

Extremely magnified stars at cosmological distances

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ABSTRACT

The first serendipitous detection of a highly magnified star at z=1.49 has opened a new window to observe individual stars at cosmological distances. Since then, several other lensed stars have been detected with Hubble Space Telescope (HST) imaging of various galaxy clusters, and nearly all galaxy clusters observed by JWST revealed lensed star candidates. Observing highly magnified stars at cosmological distances is a combined result of strong- and micro-lensing effects. The presence of point-like masses (such as stellar-mass objects) in the lens leads to the formation of micro-critical curves and micro-caustics in the lens and source planes, respectively. Whenever a star in a strongly lensed galaxy crosses a micro-caustic, it gets highly magnified, which might make it observable briefly as a transient source. In my talk, I will discuss the basic idea behind detecting highly magnified stars in cluster lenses. I will also talk about our recent detection of lensed star candidates at z≃4.8 in the MACS J0647.7+7015 galaxy cluster. The number of such lensed stars is expected to increase continuously, helping us probe the first stars and understand the compact dark matter fraction in the intracluster medium.

Keywords: *Strong gravitational lensing; Microlensing; Galaxy clusters; Stars*

IT-NPHP-5294

The Role of Nuclear Transport Codes for Advanced Nuclear Data Generation

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ABSTRACT

The development of advanced nuclear technologies, including next-generation fission reactors, fusion systems, and emerging small modular reactors, and nuclear medical fields, requires reliable and comprehensive nuclear data over a wide range of energies and reaction channels. Nuclear transport codes provide a powerful bridge between fundamental nuclear data and their practical applications by enabling detailed simulations of particle transport, nuclear reactions, energy deposition, radiation fields, and detector response.

This talk will highlight the role of nuclear transport and reaction modelling in generating, evaluating, and validating nuclear data for advanced applications. Particular emphasis will be placed on the complementary use of evaluated nuclear data libraries, nuclear reaction codes, and Monte Carlo transport tools such as MCNP, PHITS, and Nuclear Modular Codes. Examples from neutron- and charged-particle-induced reactions, activation analysis, radiation detection, and nuclear material studies will be discussed, with comparisons between computational predictions and experimental measurements.

The talk will further address the importance of uncertainty quantification, validation against experimental databases, and improved nuclear models for reducing uncertainties in simulations. The overall objective is to demonstrate how an integrated experimental–computational approach can support the generation of reliable nuclear data for advanced nuclear energy and radiation applications.

Keywords: *Transport codes, MCNP, PHITS, Nuclear Modular Codes, Nuclear Data*

IT-NPHP-5757

The Surrogate Method: Entering the Nucleus Through a Side Door

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ABSTRACT

Neutron-induced reactions play a crucial role in nuclear astrophysics, nuclear energy, and the study of the structure and decay properties of unstable nuclei. However, direct measurements of neutron-induced reaction cross sections are often difficult or impossible for short-lived radioactive nuclei because suitable targets cannot be prepared. The surrogate reaction method provides an indirect approach to determine such cross sections by producing the same compound nucleus through a different, experimentally accessible reaction. In this method, a projectile is used to transfer nucleons or induce a direct reaction on the target nucleus, forming the compound nucleus at comparable excitation energies and angular-momentum distributions to those populated in the desired neutron-induced reaction. The subsequent decay probabilities of the compound nucleus are measured experimentally, typically through detection of fission fragments or emitted particles and γ-rays. These experimentally determined decay probabilities, combined with an appropriate theoretical description of the compound-nucleus formation and angular-momentum distribution, are used to extract the desired neutron-induced reaction cross section. The method offers a valuable alternative for investigating reactions involving unstable or difficult-to-produce nuclei. Particular attention is required to account for differences in spin-parity distributions between the surrogate and neutron-induced reactions. Improved experimental techniques and statistical-model calculations can reduce these uncertainties, making the surrogate method an important tool for obtaining neutron-induced cross sections where direct measurements are not feasible.

Keywords: *Neutron cross section, Complete fusion, Transfer reaction, Surrogate method*

IT-NPHP-5806

Surrogacy vs Direct reaction: Pros and Cons

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ABSTRACT

Surrogate reaction methods provide an excellent opportunity to execute the experiment in the absence of neutron beam or having unstable target. In such kind of situation surrogacy idea came as a revolution in the field of Nuclear Physics. But this procedure has some limitations as well restrictions in terms of energy range and spin dependence. The details about direct and surrogate methods will be presented during the conference in details.

Keywords: *Nuclear reaction, Surrogate method, Neutron detector, Spin dependence*

IT-RSES-1517

Thermal performance of a dual-purpose solar box cooker for simultaneous cooking and drying food with auxiliary heating

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ABSTRACT

Multipurpose domestic solar thermal systems have the advantage that two or more solar thermal processes can be performed simultaneously. In this paper, an experimental investigation of a solar box cooker for simultaneous food cooking and drying, with auxiliary heating provided by DC positive-temperature-coefficient (PTC) heaters, is presented. The PTC heaters provide additional heating during cloudy periods, effectively enhancing the performance of the solar box cooker for simultaneous cooking and food drying. The solar box cooker also has six (6) thermal energy storage (TES) cans with a mass of 800 g each, placed beneath the cooking/drying pan to store thermal energy simultaneously during solar cooking and drying. The six storage materials are granite pebbles. silica pebbles, powdered iron filings (Fe), sodium thiosulfate pentahydrate ($Na_2S_2O_3.5H_20$) and two mixtures of sodium thiosulfate pentahydrate and powdered iron filings in ratios of 90 % $Na_2S_2O_3.5H_20$: 10 % Fe and 80 % $Na_2S_2O_3.5H_20$: 20 % Fe. Results show that it is possible to dry 150 g of apples to final dried masses of 17.3% and 19.3% of the initial mass twice during a 10-hr simultaneous solar cooking and drying period. During the same period, 1 kg of water was boiled twice, 200 g of rice in 400 g of water was well-cooked, and 530 g of chicken and mixed vegetables were cooked. The storage materials exhibit higher temperatures in the porous media (silica and granite pebbles) during the solar heating phase. Compared with the case without PTC heating and TES, 1 kg of water only achieved a temperature of 70 ºC after 4 hours, without the drying load, showing that PTC heating allows for dual-purpose operation.

Keywords: *Box solar cooker, Positive temperature coefficient (PTC) heaters, Simultaneous solar cooking and drying, Thermal energy storage (TES)*

IT-RSES-3698

The influence of turbulence modelling on heat and mass transfer characteristics in indirect solar dryers

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ABSTRACT

In Computational Fluid Dynamics (CFD) simulations of heat and mass transfer in solar dryers, several different turbulence models are used in literature. These models are often indirectly validated by comparing simulated temperatures within the dryer with experiments. However such an indirect approach allows modelling errors to compensate each other, meaning the model with best temperature resemblance with experiments is not necessary the best one with respect to prediction of the flow field within the dryer. Therefore, the aim of this study is to validate the predicting capabilities of four Reynolds Averaged Navier Stokes (RANS) turbulence models by direct comparison with Particle Image Velocimetry measurements within a forced convection indirect solar dryer. The different models tested are the standard, realizable and RNG k-ε models and the k-ω SST model. Experimental measurements were performed for two inlet velocities, 0.35 and 3.5 m/s. It was shown that the k-ω SST model demonstrates the closest agreement with experimental data. Results show that higher inlet airflow velocities promote more uniform airflow and improved drying homogeneity. The integration of advanced CFD modelling with state-of-the-art PIV validation establishes a new standard for the design and optimization of solar food dryers, supporting enhanced energy efficiency and product quality.

Keywords: *Indirect solar dryers, Particle Image Velocimetry, Computational Fluid Dynamics, Turbulence modelling, Drying performance*

IT-RSES-8846

Polymer-mixed Sb_2Te_3/Te nanocomposites exhibiting p-type to n-type conduction reversal and thermal conductivity reduction

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ABSTRACT

Sb_2Te_3-based materials are potential room-temperature thermoelectric materials. In the present work, we choose polycrystalline Sb_2Te_3/Te nanocomposites and utilize Poly Methyl Methacrylate (PMMA) to reduce the thermal conductivity of Sb_2Te_3 samples. PMMA and polycrystalline Sb_2Te_3/Te were well mixed using ball milling. Pellets have been made by the cold press method. Thermoelectric transport properties of Sb_2Te_3/Te nanocomposites: composition, microstructure, and analysis are found to be influenced by PMMA. With increasing PMMA concentration a p-type to n-type transition has been observed because there are fewer charge carriers or the composites have a higher resistance. It is also observed that the thermal conductivity of Sb_2Te_3/Te nanocomposites decreases as the PMMA increases. This research paves the way for making the best thermoelectric materials by reducing thermal conductivity through the use of polymers.

Keywords: *Thermoelectric, Polycrystalline, Nanocomposites, Thermal conductivity*

IT-RSES-9042

Innovations in decentralized energy solutions: Opportunities in Latin America

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ABSTRACT

Latin America claims some of the world's most robust solar resources, making it a highly profitable landscape for decentralized solar thermal energy. While large-scale solar PV often dominates the conversation, decentralized solar thermal—utilized for localized water heating, industrial heat, and thermal storage—is experiencing a surge in adoption, led by robust growth in countries such as Chile, Brazil, Mexico, and Argentina.

High-Impact Opportunities

- **Industrial Heat Decarbonization:** Industries such as food and beverage, mining, textiles, and chemicals rely heavily on low- to medium-temperature heat. Decentralized Solar Heat for Industrial Processes (SHIP) allows facilities to generate heat on-site, displacing fossil fuels, insulating operations from volatile energy prices, and attaining corporate sustainability targets.
- **Residential and Commercial Water Heating:** Domestic and commercial hot water demand is a major volume driver. In 2024, Brazil and Mexico saw substantial growth in solar thermal capacity additions (10.8% and 10%, respectively), fueled by strong construction sectors and government initiatives to build domestic supply chains. Hospitals, hotels, and multifamily buildings are prime targets for these retrofits.
- **Thermal Storage and Hybridization (PVT):** The intermittency of solar is being solved by advanced thermal energy storage (using phase-change materials or molten salts) that provides dispatchable heat after sunset. Furthermore, the rise of Photovoltaic Thermal (PVT) systems—which capture usable heat while simultaneously cooling the PV cells to generate electricity—presents a highly efficient hybrid solution for urban footprints where space is constrained.
- **"Solar as a Service" (SaaS):** The primary barrier to solar thermal is the high upfront capital cost. Innovative financing models like SaaS or Energy Service Companies (ESCOs) are circumventing this by covering the installation costs and charging customers only for the thermal energy they consume, democratizing access for smaller businesses and residential complexes.

Market Drivers

- **Grid Constraints:** Transmission bottlenecks are a common bottleneck across Latin America. Decentralized thermal solutions alleviate grid stress by handling heavy heating demands directly at the point of consumption, bypassing the electrical grid entirely.
- **Aggressive Transition Targets:** Through initiatives like the Renewable Energy for Latin America and the Caribbean (RELAC), the region aims for 70% renewable energy by 2030. Policymakers are increasingly recognizing that decarbonizing *heat* is just as critical as decarbonizing electricity.

While solar thermal faces stiff competition from rapidly declining solar PV costs, the efficiency of direct heat conversion and the growing need for dispatchable energy storage make it a resilient and growing pillar of Latin America's energy transition.

Keywords: *Sustainable development goals; Decentralized energy solutions; Sustainability; Clean energy solutions.*

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Semiconductor Materials for Gamma-Ray Shielding Applications: A Review

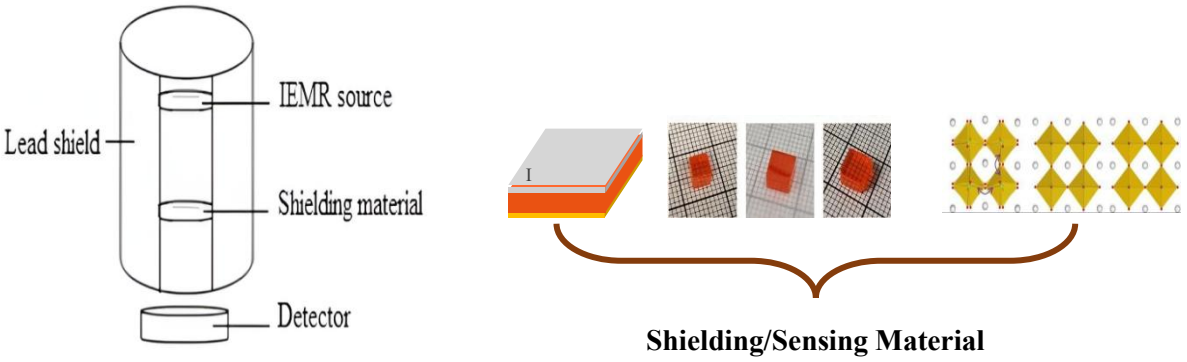
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ABSTRACT

Gamma rays, a form of high-energy electromagnetic radiation, pose significant health risks due to their penetrating power. Effective shielding materials are crucial to mitigate this hazard. Traditionally, materials like lead have been used for gamma ray shielding, but recent research has explored the potential of semiconductors for this application. Semiconductors, materials with electrical conductivity intermediate between conductors and insulators, offer several advantages for gamma ray shielding, such as (i) High Density, which contributes to their ability to absorb gamma rays. A higher density material offers more atoms per unit volume, increasing the probability of gamma ray interaction; (ii) High Atomic Number: leading to increased interaction with gamma rays through processes like photoelectric absorption and Compton scattering; and (iii) Tunable Properties: semiconductors can be tailored through doping and alloying. While semiconductors offer promising potential, challenges remain in terms of Cost, Mechanical Properties, and Radiation Damage of Composite Materials, Nanostructured Materials, and Novel Semiconductor Materials. In conclusion, semiconductors offer a promising avenue for the development of advanced gamma ray shielding materials. Their unique properties, coupled with ongoing research efforts, hold the potential to revolutionize radiation protection in various fields.

Keywords: *Gamma-ray shielding, Semiconductor materials, Radiation protection, Attenuation properties, Material optimization*



ICAPST-2026-AMNS-105067

Structural, Morphological and Optical Properties of Sr substituted La_2CrMnO_6 Double Perovskite

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ABSTRACT

This work systematically investigates the impact of high-concentration strontium doping at the A-site on the structural, morphological, and optical characteristics of $La_{2-x}Sr_xCrMnO_6$ (x = 0.50, 1.00, 1.50) double perovskites synthesized via the sol-gel auto-combustion route. X-ray Diffraction (XRD) coupled with Rietveld refinement confirms the formation of a crystalline structure with characteristic lattice symmetry. The high-level substitution of host La^{3+} (1.36 Å) ions by larger Sr^{2+} (1.44 Å) ions induces heavy structural distortions. It alters the internal Cr/Mn-O-Cr/Mn bond angles, evidenced by prominent XRD peak shifts. Field Emission Scanning Electron Microscopy (FE-SEM) micrographs reveal granular surface morphologies and a decrease in average grain size with increasing Sr substitution. Energy-Dispersive X-ray Spectroscopy (EDS) elemental mapping confirms homogeneity. Optical studies using UV-Visible Diffuse Reflectance Spectroscopy (DRS) show strong visible-light absorption. Tauc plot analysis reveals that heavy Sr incorporation systematically tunes the optical band gap, driven by extensive charge compensation and mixed-valence states. These insights demonstrate that A-site Sr substitution is an effective strategy for structural and optical band gap engineering, making this material a promising candidate for industrial-scale applications as solid oxide fuel cells, lead-free solar cells, photovoltaics, superconductors, spintronics, and magnetoelectric devices.

Keywords: *Sr-substitution, XRD, EDS-mapping, Optical band gap*

ICAPST-2026-AMNS-108166

Structural, Morphological & Optical properties of Pr-doped $BaSnO_3$ perovskite

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ABSTRACT

In this study, Ba1-xPrxSnO3 (x=0.00, 0.10, 0.15 & 0.20) ceramics are prepared by the sol-gel technique. This route facilitated homogeneous mixing of precursors, resulting in improved compositional uniformity and phase purity. The structural, morphological & optical properties of these samples are examined by XRD, SEM & UV-Visible Spectroscopy. X-ray diffraction (XRD) analysis confirmed the formation of a single-phase cubic perovskite structure, indicating the successful incorporation of Pr ions into the $BaSnO_3$ lattice without detectable secondary phases. The observed variations in lattice parameters and crystallite size suggest that Pr incorporation induced structural distortion within the $BaSnO_3$ crystal lattice. Surface morphology examined by scanning electron microscopy (SEM) revealed uniformly distributed grains with reduced agglomeration. UV–Visible spectroscopy showed a reduced optical band gap, attributed to Pr-induced localized electronic states that enhance visible-light absorption. The systematic investigation of the structural, morphological & optical evolution provides valuable insights into the compatibility and microstructural characteristics of Pr-doped BaSnO3, highlighting its suitability for advanced electronic and optoelectronic applications. These findings and their significance will be explained further during the conference presentation.

Keywords: *$BaSnO_3$ perovskite, Praseodymium doping, Sol–gel synthesis, XRD*

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Impact of Li doping on structural, optical, and electronic properties of ZnO nanoparticles

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ABSTRACT

Li-doped ZnO nanoparticles were prepared using the co-precipitation technique. Experimental techniques such as X-ray diffraction (XRD), scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS), UV-Vis spectroscopy, photoluminescence (PL), and FT-IR spectroscopy were employed to investigate the effect of Li doping on the structural, optical, and electronic properties of ZnO nanoparticles. XRD analysis confirms the formation of a single-phase hexagonal wurtzite structure without any secondary phases, and the crystallite size for the (101) peak lies in the range of 35 nm to 49 nm. Optical studies revealed a decrease in band gap with increasing Li concentration. XPS analysis verifies the oxidation states and presence of Zn, O, and Li atoms, confirming successful doping and high chemical purity of the samples. Characteristic Zn–O vibrational modes observed in the FTIR spectra confirm the successful formation of the ZnO lattice. Morphological studies revealed particle sizes ranging from 30 nm to 100 nm. XPS and PL studies confirmed that oxygen vacancies increased with increasing Li concentration.

Keywords: *Li-doped ZnO, Wurtzite structure, Absorption band edge, Oxygen vacancies*

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Harnessing synergistic effects of SPM nanoferrites for bio-magnetic engineering

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ABSTRACT

Precise size modulation, surface functionalization and biocompatibility of spinel nanoferrites (NFs) is crucial for enriching their micro-structural, magnetic and induction heating characteristics for magnetic hyperthermia-based cancer therapy. Here in, three mixed valent NFs viz; (i) $Zn_{0.7}Ca_{0.15}Mg_{0.15}Fe_2O_4$ (ZCMF), (ii) $Zn_{0.35}Co_{0.35}Ca_{0.15}Mg_{0.15}Fe_2O_4$ (ZCCMF) & (iii) $Co_{0.7}Ca_{0.15}Mg_{0.15}Fe_2O_4$ (CCMF) were fabricated using sugarcane + lemon juice mediated facile green solution based self-combustion route and examined by variety of techniques. PXRD, FTIR, RAMAN, HRETEM & ^{57}Fe Mössbauer spectroscopic analysis revealed formation of phase pure 6-7 nm sized NFs with surface functionalization by a sugar layer over the core of NFs. These NFs exhibited SPM character at 300K with decent magnetization. Notably, water-based fluid of these NFs showed excellent induction heating response in RF fields. A swift rise in the temperature up to 48 °C - 78 °C in ~ 400 secs and quite high specific absorption rate (SAR) in the range 1400-2513 W/g in the hyperthermia window were observed for these NFs. *In-vitro* analysis affirmed good biocompatibility of these NFs and lethality against breast cancer cell in hyperthermia window at minimal concentration of 0.1-2.5 mg/mL. Our findings inferred that greenly synthesized NFs have tremendous potential for nanoheaters and magnetic hyperthermia-based cancer therapies in RF fields.

Keywords: *Green synthesis, Surface functionalization, Superparamagnetism, Hyperthermia, Cytotoxicity.*

ICAPST-2026-AMNS-121912

Antifertility Potential of Plants based Bioactive Nanoparticles: Advancement in Pharmacological and Biomedicinal Applications

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ABSTRACT

Delonix regia was selected for this study because of its rich phytochemical composition, including flavonoids, tannins, and β-sitosterol, and its reported effects on male reproductive function. The present study evaluated the antifertility potential of silver nanoparticles (AgNPs) synthesized using a 50% ethanolic leaf extract of *D. regia* in adult male Wistar rats. The synthesized AgNPs were characterized by UV–Visible spectroscopy, FTIR, X-ray diffraction, and zeta potential analysis. Male rats were divided into five groups (n = 7) and orally administered *D. regia*-mediated AgNPs for 60 days, followed by a 30-day recovery period. Reproductive organ weights, fertility index, testosterone, tissue biochemical parameters, hematological and serum biochemical profiles, and testicular histology were evaluated. Treatment produced dose-dependent reductions in reproductive organ weights, fertility index, serum testosterone, testicular cholesterol, epididymal sialic acid, and adrenal ascorbic acid. Histological examination revealed degeneration of seminiferous tubules and suppression of spermatogenesis, particularly at higher doses. Hematological and routine serum biochemical parameters remained within normal physiological limits, indicating minimal systemic toxicity. These findings demonstrate that *D. regia*-mediated AgNPs possess significant, reversible, dose-dependent antifertility activity and may serve as a promising plant-based, non-hormonal male contraceptive, although further studies are required to clarify the underlying mechanisms and long-term safety.

Keywords: *Nanoparticle, Antifertility, Contraception, Characterization, Delonix regia.*

ICAPST-2026-AMNS-125901

Plant-Mediated Green Synthesis of Silver Nanoparticles Using Graptopetalum macdougallii: Structural and Morphological Characterization

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ABSTRACT

In this study, we report a simple, eco-friendly, and sustainable approach for the green synthesis of Silver Nanoparticles (Ag NPs) using Graptopetalum macdougallii plant extract as a natural reducing and stabilizing agent. This plant-mediated synthesis offers an alternative to conventional chemical and physical methods by minimizing hazardous chemicals and energy-intensive processing conditions. The formation of Ag NPs was initially confirmed by UV –Vis spectroscopy, which revealed the characteristic surface Plasmon resonance associated with silver nanoparticles. The structural properties of the synthesized AgNPs were investigated using X-ray diffraction (XRD), which confirmed their crystalline nature and was used to examine surface morphology and particle characteristics, while energy-dispersive X-ray spectroscopy (EDX) confirmed the elemental composition and the presence of silver. Photoluminescence (PL) spectroscopy was further used to investigate the optical emission characteristics of the synthesized nanoparticles. Combined spectroscopic, structural, elemental, and morphological analyses demonstrate the successful formation of AgNPs through a plant-mediated green synthesis route. The use of *Graptopetalum macdougallii* highlights this plant's potential as a sustainable biological source of Ag NPs for environmental, catalytic, sensing, and other emerging technological applications.

Keywords: *Silver Nanoparticles, Green Synthesis, Graptopetalum macdougallii plant, XRD, SEM-EDX. Photoluminescence*

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Optimized Wavy Silver Nanorod Arrays for Advanced SERS Biosensing

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ABSTRACT

We have fabricated silver nanorods on commercially purchased DVDs with a wavy pattern (DVD-AgNRs) and 0.6 mm polycarbonate surface using the glancing-angle deposition (GLAD) technique to enhance surface-enhanced Raman spectroscopy (SERS) performance. The optical and plasmonic properties of Ag nanorods grown on the grooved DVD pattern were studied and optimized. The ability of these nanorods has been investigated using 2-di(4-pyridyl)ethylene (BPE) as the Raman probe molecule. A 2-fold SERS enhancement has been observed for these substrates compared with conventional silver nanorods (AgNRs). The limit of detection (LOD) of BPE using AgNHs has been determined to be 10^{-15} M. Further, these substrates enhance the SERS signal of lab-cultured biologically significant bacteria (E. coli). The formation of high-density 'hotspots' among the DVD-AgNR arrays, along with increased surface area, provides more binding sites and, consequently, greater entrapment, thereby increasing the net effective contact area between the bacteria and the plasmonic metal surface.

Keywords: *Surface-enhanced Raman spectroscopy, DVD pattern, Ag nanorods, Glancing Angle deposition, hotspots.*

ICAPST-2026-AMNS-133249

Effect of Cu Doping on Structural, Optical, and Thermal Properties of ZnO/PEDOT: PSS Composite Thin Film

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ABSTRACT

This study reports the synthesis of pure and Cu-doped ZnO nanorods (NRs) using a simple and cost-effective chemical method to examine the influence of Cu doping on the morphological, optical, and thermal properties of ZnO NRs. The Cu-doped ZnO NRs retained the hexagonal wurtzite crystal structure and nanorod morphology observed in pristine ZnO. Cross-sectional field emission scanning electron microscopy (FE-SEM) was employed to determine the film thickness, revealing a thickness of approximately 900 nm for pure ZnO NRs with an average diameter of about 250 nm. The incorporation of Cu into the ZnO lattice significantly modified the optical bandgap, resulting in a blue shift along with a shift of the absorption edge toward higher wavelengths. Raman spectroscopy confirmed the crystalline nature of the synthesized samples through the presence of characteristic vibrational peaks. In addition, the thermal properties of composites consisting of pure and Cu-doped ZnO NRs embedded in poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) were investigated over the temperature range of 273-353 K. The findings provide valuable insights into the thermal behaviour of these composite films, highlighting their potential for a wide range of practical applications.

Keywords: *Zinc oxide (ZnO), PEDOT: PSS, Thermal conductivity, Raman spectra.*

ICAPST-2026-AMNS-136043

Fabrication of a copper ferrite nanoparticle-modified electrode for selective dopamine detection

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ABSTRACT

Dopamine is an essential neurotransmitter involved in numerous physiological functions, and diagnosing neurological disorders requires precise detection of this neurotransmitter. This paper presents the development and characterization of an electrochemical sensor based on copper ferrite ($CuFe_2O_4$) nanoparticles for sensitive detection of Dopamine (DA). $CuFe_2O_4$ was synthesized via a facile co-precipitation method and applied as a modifier on a glassy carbon electrode. The sensor exhibited excellent electrocatalytic activity for the simultaneous sensing of ascorbic acid, dopamine, and uric acid, with a low detection limit of 0.54 μM. This study highlights the potential of $CuFe_2O_4$-based sensors in biomedical diagnostics and neurotransmitter monitoring.

Keywords: *Copper ferrite, Glassy Carbon Electrode, Dopamine, Differential Pulse Voltammetry, Cyclic Voltammetry.*

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Laser-Driven Phase Evolution and Morphology Control in High-Entropy Alloy Nanoparticles

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ABSTRACT

High-entropy alloy nanoparticles (HEA-NPs) offer a compositionally tunable platform for catalysis and energy-relevant reactions, but controlling nanoscale phase selection and elemental redistribution remains challenging. Here, we present a sequential laser strategy, pulsed laser ablation in liquid (PLAL) followed by laser processing in liquid (LPL), to engineer morphology and phase evolution in non-equiatomic HEA-NPs. Burst-mode picosecond PLAL in deionized water produced FeMnNiAlSiC NPs containing B2, γ-brass, Fe_5Si_3-type, and BCC phases, with size-dependent partitioning (B2-enriched larger NPs; Si/Mn-rich smaller NPs) and an inherent laser-driven annealing signature. Subsequent nanosecond LPL induced pronounced restructuring, including hollow NP formation (attributed to asymmetric Ostwald ripening) and enhanced crystallinity, accompanied by the evolution and stabilization of B2 and Fe_5Si_3-type phases consistent with a laser-annealing effect. Further, FeMnNiAlCrSiC (HEA-Cr) and FeMnNiAlTiSiC (HEA-Ti) reveals that Si critically drives intermetallic formation, while Cr and Ti modulate both elemental homogeneity and silicide selection: HEA-Cr showed spatial segregation (Al at edges; Fe-Ni-rich regions; Si accumulation) and forms Fe_5Si_3/Cr_5Si_3 that grow after processing, whereas substituting Cr with Ti improved mixing and promoted Ti_5Si_3-type phases after processing. Thermodynamic analyses support a processing-induced shift from mixed solid-solution/intermetallic states toward intermetallic-dominant structures. This work highlights a general route for laser-induced phase/precipitate engineering in complex alloys.

Keywords: *Laser matter interaction, High entropy alloy, Nanoparticles, Phase engineering,*

ICAPST-2026-AMNS-157602

Selective CO_2 Reduction to Methanol on Ag_5Cu_3 Bimetallic Nanoclusters: A DFT Study

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ABSTRACT

The selective electrochemical reduction of CO_2 to value-added products such as methanol is promising for carbon utilization and emission reduction. However, achieving high selectivity remains challenging. Copper-based bimetallic nanoclusters are particularly promising due to their tunable properties and ability to facilitate multi-electron transfer and promote the formation of hydrocarbons and oxygenated products.

In this study, DFT calculations were performed to investigate the composition-dependent CO_2 adsorption and product selectivity of sub-nanometer Ag_xCu_{8-x} clusters (x = 5–8). Among the studied clusters, Ag_5Cu_3 showed the most favourable CO_2 interaction, with an adsorption energy of -0.21 eV and an increase in the C–O bond length from 1.16 to 1.17 Å, indicating CO_2 activation. In contrast, Ag_6Cu_2, Ag_7Cu, and Ag_8 showed negligible CO_2 interaction, demonstrating the importance of Cu content and atomic composition.

For Ag_5Cu_3, the CO–CO coupling barrier of 4.66 eV indicates that C_2 product formation is highly unfavourable, thereby favouring the C_1 product CH_3OH. Moreover, CH_3OH desorption requires 0.43 eV without a catalyst, whereas Ag_5Cu_3 provides a favourable desorption free energy of -0.56 eV, facilitating product release. Overall, Ag_5Cu_3 with an optimal Ag/Cu ratio of 5:3 is a promising catalyst for selective CO_2 conversion to CH_3OH.

Keywords: *CO_2RR, Cu-Ag cluster, DFT, CH_3OH, CO_2 Activation, Composition Effect.*

ICAPST-2026-AMNS-197538

Plant-Assisted Green Synthesis of $NiFe_2O_4$ Nanoparticles Using Lemon Extract and Their Structural Properties

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ABSTRACT

Nickel ferrite ($NiFe_2O_4$) nanoparticles were synthesized via a green and environmentally sustainable sol–gel route using fresh *Citrus limon* (lemon) extract as a natural chelating and fuel agent. The structural, morphological, vibrational, and optical properties of the synthesized nanoparticles were investigated using X-ray diffraction (XRD), field-emission scanning electron microscopy (FESEM), Raman spectroscopy, Fourier-transform infrared (FTIR) spectroscopy, and UV–Vis spectroscopy. XRD analysis confirmed the formation of crystalline $NiFe_2O_4$ with a cubic spinel structure and a lattice parameter of approximately 8.33 Å. The crystallite size, estimated from the broadening of the XRD diffraction peaks, was found to be in the range of 5–18 nm, confirming the nanoscale nature of the synthesized material. FESEM observations further revealed the nanocrystalline morphology of the sample. The Raman and FTIR spectra confirmed the characteristic vibrational modes associated with the metal–oxygen bonding and spinel ferrite structure. UV–Vis spectroscopic analysis revealed a variation in the optical band gap, which can be correlated with the particle-size-dependent electronic structure of the nanoparticles. The combination of a green synthesis approach, nanoscale crystallinity, and tunable optical properties highlights the potential of the synthesized $NiFe_2O_4$ nanoparticles for applications in magnetic devices, chemical sensors, catalysis, microwave absorption, and biomedical technologies.

Keywords: *Green synthesis, Ferrite, XRD, Nanoparticle.*

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$La_{0.05}NiFe_{1.95}O_4/g\text{-}C_3N_4$ Nanocomposites for Photocatalytic Degradation and Humidity Sensing Applications

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ABSTRACT

In the current investigation, $La_{0.05}NiFe_{1.95}O_4/g\text{-}C_3N_4$ (La-Ni ferrite/g-CN) nanocomposites were fabricated by the chemical co-precipitation technique with varying ferrite-to-g-C_3N_4 proportions of 1:1, 1:2, and 1:3. The synthesized compounds were examined for their diverse uses in the photocatalytic breakdown of Rose Bengal and tetracycline, in addition to humidity detection. The integration of g-C_3N_4 with $La_{0.05}NiFe_{1.95}O_4$ is anticipated to augment charge separation, elevate surface activity, and offer supplementary active sites, consequently facilitating the breakdown of organic contaminants. The photocatalytic efficacy of the produced composites was assessed by observing the degradation of Rose Bengal and tetracycline under light exposure, while their humidity-sensing properties were examined by detecting the changes in electrical response with varying relative humidity. The effect of the $La_{0.05}NiFe_{1.95}O_4/g\text{-}C_3N_4$ ratio on photocatalytic performance and moisture sensitivity was thoroughly investigated. The composite featuring an optimum ratio of ferrite to g-C_3N_4 is expected to demonstrate superior photocatalytic performance and higher humidity sensitivity due to the synergistic effects of the magnetic ferrite and semiconducting g-C_3N_4 components. The versatile characteristics of these composites underscore their capability for concurrent environmental cleanup and moisture-detection uses.

Keywords: *La-Ni ferrite, g-C_3N, Photocatalyst, Humidity sensing, Environmental remediation.*

ICAPST-2026-AMNS-227837

Study of Structural and Optical Properties of Pure and Ni-doped TiO_2 Nanoparticles

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ABSTRACT

TiO_2 is widely used because of its good biocompatibility and stability Ní-doped TiO_2nanoparticles were synthesized by the co-precipitation method. X-ray diffraction (XRD) analysis confirmed the formation of single-phase rutile TiO_2, with the prominent (110) diffraction peak observed at $2\theta \sim 27.6°$, and no secondary impurity phases, indicating successful substitutional incorporation of Ni ions into the TiO_2 lattice. A slight shift in diffraction peaks with increasing cobalt concentration suggested lattice distortion due to dopant incorporation. FTIR spectra recorded in the range 400-4000 cm^{-1} exhibited characteristic Ti-O-Ti stretching vibrations in the region 450-700 cm^{-1}. The absence of additional impurity-related bands confirmed phase purity, while minor band broadening in doped samples indicated structural modification caused by cobalt incorporation. UV-Visible absorption spectra showed enhanced absorption in the visible region. The optical band gap decreased systematically from 3.02 eV to 2.81 eV with increasing Ni concentration, indicating band structure modification due to dopant-induced defect states.The study confirms that controlled Ni doping effectively tunes the structural and optical properties of TiO_2.

Keywords: *XRD, Rutile, UV-Visible Spectroscopy, Band Gap*

ICAPST-2026-AMNS-272922

Synthesis, Structural Characterization, and Potential Applications of Ni-Doped f/MWCNT Nanocomposites

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ABSTRACT

Carbon nanotubes (CNTs) make excellent supports for metal nanoparticles due to their high surface area and chemical stability. These CNT-metal composites have diverse applications. Several methods are available to anchor metal nanoparticles onto CNTs. In this study, Ni nanoparticles were synthesized and subsequently deposited onto the surface of multi-walled CNTs, forming a nanocomposite material. The synthesized Ni-f/MWCNT nanocomposite was thoroughly examined by XRD, Raman, FTIR, UV-Vis, FESEM, EDX, and BET/BJH techniques. XRD analysis confirmed crystalline metallic Ni on f/MWCNTs, with a strong preferred orientation along the (111) plane, and corroborated the presence of both graphitic carbon and crystalline Ni phases. Raman results showed a rise in defects in Ni-f/MWCNT, indicating strong coupling between Ni nanoparticles and the f/MWCNT structure. FESEM and EDX results confirmed that Ni nanoparticles were evenly dispersed across the MWCNT surface. BET results showed the surface area dropped from 11.423 to 5.544 m^2g^{-1} after Ni loading, likely due to pore blocking. BJH data indicated pore volume increased from 0.002 to 0.008 cm^3 g^{-1} while average pore size decreased from 21.544 to 16.804 Å, confirming clear changes in the mesoporous structure. Overall results suggest that Ni/f-MWCNT nanocomposites have promising features for hydrogen storage, catalysis, gas sensing, and other energy applications.

Keywords: *Nanocomposite, Wet chemical method, Mesoporous, MWCNT.*

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Structural, magnetic, electronic and thermoelectric properties of CrVTiAl quaternary Heusler compound using FP-LAPW method: A first-principles study

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ABSTRACT

This present work investigates the physical properties of quaternary Heusler CrVTiAl compound using density functional theory based first-principles calculations, where the full potential-linearized augmented plane wave (FP-LAPW) technique has been used in WIEN2K and BoltzTraP simulation codes. The structure optimization resulted in an equilibrium lattice constant (6.024 Å) and a bulk modulus (124.527 GPa). The electronic structure analysis shows that CrVTiAl is a semiconductor with a direct band gap of 0.364 eV. Magnetic properties analysis confirms the antiferromagnetic nature of the studied material. The thermoelectric parameters were computed at three different temperatures 300, 600, and 900 K. It was found that CrVTiAl shows highest power factor per unit relaxation time in n-region (13.20×10^{11} unit) at 900 K and decreases with decreasing temperature and become (6.73×10^{11} unit) at 300 K. Thus, the present work reveals the high potential of investigated quaternary Heusler material CrVTiAl for thermoelectric applications.

Keywords: *Quaternary Heusler semiconductor; Density functional theory; electronic properties; Magnetic properties; Thermoelectric properties*

ICAPST-2026-AMNS-294974

Doping-Induced Defect and Surface Modulation in SnO_2 for Enhanced Gas Sensing Performance

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ABSTRACT

Gas sensing plays an important role in environmental monitoring and industrial safety, especially in the detection of hazardous gases. Tin oxide (SnO_2) is a promising material for gas-sensing applications. However, achieving high sensitivity and effective sensing at lower operating temperatures remains challenging. This review focuses on how doping influences the gas-sensing properties of SnO_2 for high-sensitivity gas detection. Particular attention is given to doped SnO_2 systems used for detecting NO_2, CO, H_2, NH_3, and volatile organic compounds, with emphasis on sensitivity, selectivity, response/recovery behaviour, and operating temperature. It has been observed that suitable doping can modify the electronic structure and surface chemistry of SnO_2, change the concentration of oxygen vacancies, and improve gas adsorption and charge-transfer processes. These changes can enhance sensing sensitivity and selectivity and may also help reduce the operating temperature. Furthermore, the interaction between dopants, defects, and surface-active sites plays an important role in determining sensing performance. Overall, doping-assisted defect and surface engineering provides a useful approach for developing high-sensitivity SnO_2 gas sensors for environmental monitoring and industrial safety applications.

Keywords: *Tin Oxide (SnO_2), Doping, Gas Sensing, Gas Sensitivity, Defect Engineering*

ICAPST-2026-AMNS-312355

Multi-Property Investigation of Unfilled Binary AB_3 Skutterudites (A= Ir, Rh; B= P, As, Sb): Structural, Electronic, Optical, Thermal, and Thermoelectric

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ABSTRACT

The body-centered cubic AB_3 (A= Ir, Rh; B= P, As, Sb) Binary Skutterudite with space Im-3(204) group, have been examined using the WIEN2k code, FP-LAPW method is used to perform first-principles calculations based on DFT. PBE-GGA exchange-correlation potential is used to analysis the structural, electronic, optical, and thermoelectric properties. Electronic structure and density of states show that the compounds are metallic in nature. To ensure structural stability, shear modulus, poisson's ratio, elastic coefficient, anisotropy, young's modulus, and Pugh ratio are computed. By calculating the mechanical properties, the ductile behaviour of the compounds can also be established, indicating potential suitability for engineering and industrial applications. Optical properties such as dielectric constant, conductivity, absorption, refractive index, and reflection are also calculated. Furthermore, the thermodynamic properties were investigated 100-800 K temperature range with pressures ranging from 0 to 40 GPa, implementing the quasi-harmonic Debye model. Transport coefficients, including the Seebeck coefficient, electrical conduction, electronic thermal conduction, and figure of merit, are evaluated within the BoltzTraP code. Computations indicated that AB_3 (A= Ir, Rh; B= P, As, Sb) are promising materials for TE, as $zT \approx 1$, and for optoelectronic applications with a high static refractive index and at UV-region show high absorption.

Keywords: *Binary Skutterudites, Density Functional Theory (DFT), Mechanical Properties, WIEN2K, Semiclassical Boltzmann Transport Theory, Thermoelectric Properties*

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Study about the Innovations in Nanotechnology and Nanomaterial Design to Real-World Applications

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ABSTRACT

Nanotechnology concerns the controlled design and application of materials with characteristic dimensions typically between approximately 1 and 100 "nm". At this scale, quantum confinement, large surface-to-volume ratio, interfacial effects, and size-dependent transport phenomena produce properties that differ substantially from those of bulk materials. This paper reviews recent innovations in nanomaterial design, including bottom-up synthesis, top-down fabrication, surface functionalization, defect engineering, heterostructure construction, and data-driven materials discovery. The discussion connects nanoscale structure with optical, electrical, mechanical, catalytic, biomedical, and environmental performance. Applications in energy storage, solar energy, water treatment, medicine, electronics, sensors, and sustainable manufacturing are examined. The paper also presents governing equations, design relationships, research challenges, and a pathway to safer, more scalable commercialization.

Keywords: *Nanotechnology, Nanomaterials, Nanocomposites, Quantum confinement, Surface engineering*

ICAPST-2026-AMNS-340765

Green-Synthesized *Cassia fistula* Silver Nanoparticles Exhibit Reversible Antifertility Effects in Male Wistar Rats: A Plant-Based Male Contraceptive Approach

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ABSTRACT

The present study was designed to investigate the antifertility effects of green silver nanoparticles synthesized from *Cassia fistula* leaf extract in male Wistar rats. The antifertility activity was assessed through body and reproductive organ weight measurements, hormonal analysis, tissue biochemical estimations, histopathological examination, and fertility studies. The herbal nanoparticles were characterized and then administered at different doses to experimental groups. Results showed a dose-dependent decrease in reproductive organ weights and lower testosterone levels in treated rats, indicating disrupted endocrine function. Tissue biochemical analysis revealed decreased levels of sialic acid in the epididymis, cholesterol in the testis, and ascorbic acid in the adrenal gland, suggesting alterations in reproductive physiology and metabolic activity. Histopathological examination demonstrated alterations in testicular architecture and reduced spermatogenic activity. This supported the antifertility effect by showing reduced reproductive performance in treated animals. Animals in the recovery group showed gradual restoration of reproductive parameters following withdrawal of treatment, indicating the reversible nature of the observed effects and suggesting that *Cassia fistula*-mediated AgNPs induce significant and reversible antifertility effects, highlighting their potential as a plant-based male contraceptive agent.

Keywords: *Cassia fistula, AgNPs, Antifertility, Characterization, Hormonal assay, Biochemical analysis*

ICAPST-2026-AMNS-355969

Investigation of Microwave Absorption and Reflection Loss Behaviour of Epoxy-Embedded Barium Hexaferrite/Carbon Black Nanocomposites in the X-Band

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ABSTRACT

With the advancement of electronic devices, the amount of electromagnetic (EM) radiation has increased significantly. This EM radiation can interfere with other electronic devices and degrade their performance. To address this issue, microwave-absorbing materials are necessary to protect the electronic circuitry in modern electronic systems. This work explores the synthesis of carbon black (CB) and barium hexaferrite nanocomposites embedded in epoxy resin for microwave absorption applications in the X band. The nanocomposites were synthesized via physical mixing and characterized using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), and scanning electron microscopy (SEM). Complex permittivity and permeability of the nanocomposites were measured using vector network analyzer (VNA), for measurements, rectangular forms samples were fabricated. Among the samples, 10% CB containing sample showed a minimum reflection loss of -15.6 dB over a bandwidth of 2.3 GHz, while 20% CB containing sample exhibited a significantly improved minimum reflection loss of -31.0 dB with a bandwidth of 2.4 GHz at a thickness of 2.5 mm, indicating 99.9% absorption of EM radiation. These findings demonstrate the suitability of the synthesized samples for the use in radar absorbing material applications.

Keywords: *Nanocomposite, Magneto-dielectric losses, Microwave absorption, Reflection loss, EMI shielding.*

ICAPST-2026-AMNS-364523

Development of Flexible Sheets of Zn^{2+}-Modified $BaFe_{12}O_{19}$/PU–PMMA Interpenetrating Polymer Network for Enhanced Magneto-Mechanical and Dielectric Properties

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ABSTRACT

Hybrid composites comprises polymer ceramic in thin flexible sheets attracts considerable attention in advanced electronic, magnetic, mechanical applications. In present study, IPNs based on polyurethane (PU) & Poly(methyl methacrylate) (PMMA) were synthesized via sequential polymerization & reinforced with controlled loadings of $Ba_{0.5}Zn_{0.5}Fe_{12}O_{19}$ Nano ceramic fillers prepared using auto-combustion method using an in-situ polymerization technique. Comprehensive characterization techniques such as FTIR, XRD, SEM, VSM & UTM, dielectric & impedance spectroscopy have been employed to evaluate the structural, morphological, magnetic, mechanical, and dielectric behavior of the prepared composites. DRS and PL spectroscopy analysis evident for establishment of optical response in non-optical polymer sheet. Substitution Zn^{2+} in $BaFe_{12}O_{19}$ at Ba^{2+} results in enhancement of magnetic and dielectric properties of due to different ionic radii whereas nanosized ceramic loadings improve mechanical performance of IPNs through strong interfacial interactions.

Keywords: *Hexaferrite, Interpenetrating Polymer Network (IPN), Magnetic properties, Dielectric properties, Mechanical properties*

ICAPST-2026-AMNS-371616

Quantitative Evaluation of Residual Stress and Nitrogen-Related Defects in Single-Crystal Diamond

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ABSTRACT

This study presents a quantitative assessment of residual stress and nitrogen-related defects in single-crystal diamonds grown by microwave plasma-enhanced chemical vapor deposition (MPCVD). Raman and Fourier-transform infrared (FTIR) spectroscopy were employed to evaluate the structural and optical quality of the diamond material. The Raman spectrum exhibited the characteristic diamond sp^3 vibrational mode near 1332 cm^{-1}, providing a basis for evaluating crystalline quality and residual stress. FTIR analysis was performed to investigate substitutional nitrogen, nitrogen aggregation, hydrogen-related defects, and non-diamond carbon. For the 300 μm-thick diamond, nitrogen-related absorption was below the measurable concentration, with the C-center (N^0_s) concentration estimated to be <10 ppm, while the A-center concentration was below 5 ppm. No distinct B-center-related features were identified. A hydrogen-related feature near 3115 cm^{-1} was also examined, while no significant sp^2/graphitic contribution was observed. The combined spectroscopic results demonstrate a low concentration of detectable impurity-related defects and good optical quality of the MPCVD-grown diamond. These characteristics make the diamond samples promising candidates for further investigation and engineering of NV-center-related defects for potential quantum sensing applications.

Keywords: *Single-Crystal Diamond, Microwave Plasma-Enhanced Chemical Vapor Deposition, Raman Spectroscopy, Fourier-Transform Infrared Spectroscopy, Residual Stress, Nitrogen-Related Defects, Quantum Material*

ICAPST-2026-AMNS-398944

Structural and Optical Properties of Al- Doped SnO_2 Nanocrystalline Semiconductors

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ABSTRACT

Pure and 2% Al-doped SnO_2 nanoparticles have been synthesized via chemical co-precipitation, followed by calcination at 800 °C for 10 hrs. Structural and optical properties were investigated using X-ray diffraction (XRD) and UV-Visible spectroscopy. XRD confirmed the formation of a single-phase tetragonal rutile SnO_2 structure, with no detectable impurity phases, indicating phase-pure Al-doped SnO_2 nanoparticles. The average crystallite size, calculated using the Scherrer equation, was found to be 40.4 nm for pure SnO_2 and 36.3 nm for 2% Al-doped SnO_2. The reduction in crystallite size with Al doping may be attributed to the inhibition of crystal growth caused by the incorporation of smaller Al^{3+} ions into the SnO_2 lattice, which restricts grain growth during calcination. UV–Visible spectroscopy was employed to determine the optical properties. The optical band gap determined by the Tauc plot was 3.85 eV for pure SnO_2 and 3.88 for 2% Al-doped SnO_2. These results suggest that Al doping modifies the optical structure of SnO_2. The widening of the band gap may be associated with the Burstein–Moss effect, reduction in crystallite size, and lattice distortion introduced by Al doping. The synthesized phase-pure Al-doped SnO_2 nanoparticles may be used for future optoelectronic and sensing applications.

Keywords: *Nanoparticles, XRD, Crystallite size, Optical band gap, UV-Visible spectroscopy.*

ICAPST-2026-AMNS-402213

Unveiling Elastic and Thermoacoustic Properties of Gadolinium Monochalcogenides

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ABSTRACT

In present study, the elastic, mechanical and thermoacoustic properties of gadolinium chalcogenides (GdX: X= S, Se, and Te) have been computed in the temperature range 0K-700K. The second and third order elastic constant (SOECs and TOCEs) of GdX are computed using the Coulomb and Born-Mayer potential model with the help of two basic parameters i.e., nearest neighbour distance and Born parameter. The Born-Huang stability criteria have been satisfied the selected materials, so these materials are mechanically stable. SOECs have been utilized to compute the elastic moduli (Young's modulus, bulk modulus, shear modulus) Pugh ratio, Zener anisotropic factor, Poisson ratio) and to compute the ultrasonic velocity. The obtained values of the elastic moduli predict the brittle nature of the selected materials. Further the ultrasonic Grüneisen parameters have been obtained with the achieved results of the SOECs and TOCEs along <100>, <110> and <111> direction for GdX. Additionally, the temperature dependent thermoacoustic parameters like Debye temperature, thermal conductivity, specific heat, energy density and relaxation time have been investigated for chosen materials. These thermoacoustic parameters confirm semiconducting nature of the gadolinium monochalcogenides. These obtained results have been discussed in correlation with available previous investigation.

Keywords: *Gadolinium monochalcogenides, Elastic constants, Mechanical properties, Grüneisen parameter*

ICAPST-2026-AMNS-414143

Tuning Bandgap and Bactericidal Efficiency in Ni^{2+} Substituted CuO Nanostructures: Structural and Optical Insights

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ABSTRACT

Copper oxide nanoparticles have emerged as promising antimicrobial agents because of their distinctive physicochemical characteristics. In this work, undoped and Ni-doped CuO nanoparticles (1%, 2%, and 3% Ni) were successfully synthesized via chemical co-precipitation. XRD analysis confirmed that Ni-doped samples preserved the pure monoclinic tenorite phase (ICDD 48-1548) without secondary NiO formation. A slight shift in peak positions with increasing Ni content confirmed successful substitution of Ni^{2+} into the CuO lattice. Debye-Scherrer and Williamson-Hall analyses revealed a progressive reduction in crystallite size with increasing Ni content. EDAX analysis confirmed the presence of Cu, Ni, and O elements, validating successful Ni incorporation into the CuO lattice with compositional purity. Tauc plot analysis of UV-DRS spectra revealed systematic bandgap narrowing, supported by increasing Urbach energy and variation in refractive index. Photoluminescence spectroscopy revealed enhanced defect-level emission with Ni doping, confirming oxygen vacancy. Antibacterial disc diffusion assay against pathogenic bacterial strains demonstrated progressively increasing zone of inhibition with Ni content, with 3% Ni-doped CuO exhibiting maximum bactericidal efficiency. These results demonstrate that doping with nickel is an efficient approach for modifying optical properties and improving bactericidal performance.

Keywords: *Ni doping, Williamson-Hall plot, Photoluminescence, Reactive oxygen species, Antibacterial activity*

ICAPST-2026-AMNS-421548

Structural, Morphological, Optical and Magnetic Properties of Sr-Doped La_2FeMnO_6 Double Perovskites

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ABSTRACT

A series of double perovskite ceramics with the general formula $La_{2-x}Sr_xFeMnO_6$ (x = 0, 0.5, 1.0, 1.5, 2.0) were synthesized via the sol–gel method, and their structural, morphological, and magnetic properties were investigated. X-ray diffraction (XRD) coupled with Rietveld refinement revealed a well-defined monoclinic structure (space group P21/n) throughout the series. At the same time, the crystallite size, estimated via the Debye–Scherrer method, ranged from 12 to 19 nm, showing a general decreasing trend with doping concentration. SEM revealed randomly distributed clusters with a quasi-spherical morphology. UV–Visible spectroscopy was used to study optical absorption and determine the band gap via Tauc plot analysis; the band gap decreased from 1.78 to 1.30 eV with increasing Sr content. FTIR confirmed strong Fe–O and Mn–O stretching modes in the 500–575 cm^{-1} region. M–H curves showed that saturation magnetization (M_s) decreased with Sr doping, attributed to anti-site disorder and weakening of Fe–O–Mn interactions, while remanent magnetization (M_r) and coercivity (H_c) increased. These variations in structural, magnetic, and vibrational characteristics collectively enhance the functional versatility of Sr-doped $La_{2-x}Sr_xFeMnO_6$, making it a promising material for optoelectronic, photocatalytic, and multifunctional oxide device applications.

Keywords: *Double perovskite oxides, Sol–gel method, X-ray diffraction, VSM, Scanning electron microscopy, UV–Visible spectroscopy.*

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Structural, optical, morphological, electronic and magnetic properties of nanosized Dy-substituted cobalt ferrite synthesized by sol-gel auto-combustion method

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ABSTRACT

Pure and Dy-doped cobalt nanoferrites $Dy_xCo_{1-x}Fe_2O_4$ (where x = 0.00, 0.02, 0.04, 0.06, 0.08, 0.1) were synthesised using the sol-gel technique. The structural characterization of these samples was done using XRD. The crystallite size decreased with increasing Dy^{3+} concentration. Rietveld's refinement of XRD patterns confirmed the formation of face-centred cubic spinel ferrite. The energy band gap decreases as Dy^{3+} composition increases. HRTEM images of $Dy_xCo_{1-x}Fe_2O_4$ (x = 0.00, 0.04, 0.08) Nano ferrites and their size-distribution histogram fitted with a Gaussian function show that the nanocrystallites are nearly spherical. The average particle sizes are 47.78, 43.81, and 39.36 nm for x = 0.00, 0.04, and 0.08, respectively, which closely match the XRD-analyzed data. We investigated the elemental chemical states of Dy-doped cobalt nanoparticles using XPS and found that the valence states of Fe, Co, and Dy are Fe^{3+}, Co^{2+}, and Dy^{3+}. Adding Dy^{3+} ions to these ferrites increased metal-oxide bonds and reduced relative oxygen vacancies. The magnetic characteristics were analyzed using the Vibrating Sample Magnetometer (VSM) of the produced Dy-doped Co ferrites in the 5 K–300 K temperature range.

Keywords: *XRD, Rietveld refinements, HRTEM, UV-Vis, FTIR, XPS, VSM*

ICAPST-2026-AMNS-428981

Insights into the Electronic Structure and Magneto-Dielectric Behavior of Nickel-Substituted Cobalt Nanoferrite

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ABSTRACT

Nickel-substituted nanocrystalline cobalt spinel ferrite $Ni_xCo_{1-x}Fe_2O_4$, where x = 0.0 to 1.0, with a gap of 0.2, synthesized by the sol-gel method, is investigated. XRD identifies spinel phases, purity, and crystallite sizes. With Ni doping, crystallites shrink from 56 to 28 nm, and the 'a' lattice constant decreases from 8.34 Å to 8.30 Å. Rietveld refinement confirms a single-phase cubic spinel ferrite. HRTEM shows morphology and particle sizes from 30 to 55 nm. FTIR validates purity. The stretching vibrations of (Fe-O) bonds at tetrahedral sites shift from 539 to 549 cm-1 as Ni concentration increases. XPS confirms electronic structure and metal-ion valence states without other elemental components. UV-visible spectroscopy shows a band gap of 1.12 to 1.60 eV that increases with Ni concentration, supporting microwave absorption and visible-light activation. Dielectric measurements showed lower-frequency dispersion in permittivity and AC conductivity, explained by Koop's model and Maxwell-Wagner interfacial polarization. Magnetic characterization revealed changes in saturation magnetization (Ms), coercive field (Hc), magnetocrystalline anisotropy, and switching-field distribution. Surface chemical states and site occupancy influence magneto-dielectric and optical properties relevant to biosensors, targeted drug delivery, MRI, and magnetic separation.

Keywords: *XRD, Rietveld refinement, HRTEM, FTIR, XPS, UV-vis, Dielectric and Magnetic properties.*

ICAPST-2026-AMNS-445849

Performance and Optimization of SnS_2/$Cs_2AgBiBr_6$/Spiro-OMeTAD Solar Cells: A SCAPS-1D Study

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ABSTRACT

Due to their low toxicity and promising optoelectronic properties, lead-free double perovskite solar cells are gaining attention. In this context, this study investigates the performance of $Cs_2AgBiBr_6$. It is a promising lead-free double perovskite material for photovoltaic applications, but charge recombination and defects affect its device performance. In this work, the performance of SnS_2/$Cs_2AgBiBr_6$/Spiro-OMeTAD is numerically investigated using SCAPS-1D and the effects of absorber thickness, operating temperature, quantum efficiency, interface defect density and absorber defect density are analysed systematically. We observed from the results that at optimized absorber thickness the device achieves 20.65% Power Conversion Efficiency (PCE). With increasing temperature, open-circuit voltage (Voc), fill factor (FF), and PCE decrease, while short-circuit current density (J_{sc}) is increases. When Interface and absorber defect density increase, carrier recombination also increases, leading to decreased photovoltaic performance. The obtained results show the importance of using SnS_2 in the form of electron transport layer (ETL) and controlling the defect density, which is useful in the optimisation of the $Cs_2AgBiBr_6$ lead-free double perovskite solar cells as the absorber layer.

Keywords: *$Cs_2AgBiBr_6$ lead-free absorber, SnS_2 electron transport layer, Spiro hole transport layer, SCAPS-1D*

ICAPST-2026-AMNS-449143

Ag-Doped ZnO: GO Thin Films as High-Performance CO_2 Gas Sensors

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ABSTRACT

Ag-doped ZnO:GO (AZG) thin films were deposited using a sol-gel spin-coating technique and investigated for carbon dioxide (CO_2) gas sensing application. The incorporation of Ag nanoparticles and graphene oxide (GO) into the ZnO matrix significantly modified the structural, optical, and surface properties of the films. XRD analysis confirmed the formation of crystalline hexagonal ZnO, while morphological studies revealed a homogeneous surface with well-distributed GO sheets. The addition of Ag and GO reduced the optical band gap and improved the electrical conductivity of the sensing layer.

AZG thin films demonstrated enhanced CO_2 sensing performance, exhibiting high sensitivity, rapid response and recovery times, and excellent stability under optimized operating conditions. The improved sensing behaviour is attributed to the synergistic interaction among ZnO, Ag, and GO. Ag nanoparticles serve as catalytic active sites, promoting oxygen adsorption and accelerating surface reactions, whereas GO provides efficient electron transport pathways and a large surface area for gas adsorption. These combined effects facilitate charge transfer, increase the density of active sensing sites, and enhance the interaction between CO_2 molecules and the sensing surface. Consequently, the developed AZG thin films show strong potential as low-cost, reliable and high-performance CO_2 gas sensors for environmental monitoring and industrial safety applications.

Keywords: *Ag-doped ZnO:GO thin films; Sol-gel spin coating; CO_2 gas sensor; Graphene oxide.*

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Quantum Oscillations and Electronic States of Cr_3Ge

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ABSTRACT

The electronic states and the Fermi surface of Cr_3Ge are investigated using full potential linearized augmented plane wave method to probe the role of electronic states around Fermi energy in ascertaining the shape and size of the Fermi surface. The Fermi surfaces are described in terms of band structure, density of states, one-dimensional electron momentum density distribution and the quantum oscillations occurring in the de Haas-van Alphen effect. The investigations are carried out with and without considering the spin-orbit interaction on the electronic states. The dimensions and shapes of the Fermi surface constituted by six bands are evaluated and interpreted using the band structure near Fermi level and the anisotropies in the directional Compton profiles. The band structure of Cr_3Ge shows characteristics of the Dirac metal at one M and three R symmetry points. These features remain on applying the spin orbit interaction. However, this interaction opens gap at some chirality points. Out of the concurrently associated bands emerging from the application of spin orbit interaction, the first and third band become hole-like and the fifth and the sixth band become electron-like. The dHvA frequency of all extreme area remain same except the sixth band wherein it doubles.

Keywords: *Cr_3Ge, dHvA oscillations, Electronic states, Fermi surface, Full potential linearized augmented plane wave method.*

ICAPST-2026-AMNS-474336

Synergistic ROS Generation and Charge Transfer in *Clitoria ternatea*-Phytosynthesized Nd_2O_3/Chitosan Nanocomposites for Enhanced Visible-Light Photocatalytic Degradation

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ABSTRACT

The persistent contamination of aquatic ecosystems by recalcitrant synthetic dyes poses a critical environmental challenge that demands efficient and sustainable photocatalytic remediation systems. In the present study, *Clitoria ternatea* leaf extract was employed as a green biogenic reducing and stabilizing agent for the synthesis of neodymium oxide/chitosan (Nd_2O_3/CH) nanocomposites. The structural, optical, surface, morphological, and electrochemical properties of the synthesized nanocomposites were comprehensively characterized using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), field emission scanning electron microscopy (FESEM), Brunauer-Emmett-Teller (BET) surface area analysis, X-ray photoelectron spectroscopy (XPS), ultraviolet-visible diffuse reflectance spectroscopy (UV-DRS), and electrochemical impedance spectroscopy (EIS). The optimized NCH2 nanocomposite exhibited outstanding photocatalytic degradation efficiencies of 94.27% for malachite green and 62.85% for rose bengal dyes under visible light irradiation. Radical scavenger studies confirmed that superoxide radicals ($\bullet O_2^-$) and hydroxyl radicals ($\bullet$OH) serve as the primary reactive oxygen species governing the photocatalytic degradation mechanism. Furthermore, the NCH2 nanocomposite demonstrated remarkable stability and reusability over successive degradation cycles with negligible loss of activity, underscoring its practical applicability. These findings establish the *Clitoria ternatea*-mediated Nd_2O_3/chitosan nanocomposite as a promising eco-friendly photocatalytic platform for effective dye wastewater remediation.

Keywords: *C. ternetea, Nd_2O_3 NPs, Chitosan, Photocatalytic degradation, Wastewater remediation*

ICAPST-2026-AMNS-479570

Cu Substitution Effect on Structural, Morphological and Optical Properties of Sr_2FeMnO_6

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ABSTRACT

In this study, A new series of Cu-doped $Sr_2Fe_{1-x}Cu_xMnO_6$ ($0.0 \leq x \leq 0.1$) double perovskite materials have been successfully synthesized by the sol-gel method, which were characterized using X-ray diffraction (XRD), scanning electron microscopy, and UV -vis spectroscopy. X-ray diffraction analysis confirms that Sr_2FeMnO_6 crystallizes in a double-perovskite structure with a cubic cell belonging to Fm3m (225) symmetry and a lattice parameter of 7.6919 A°. Using the Scherrer equation, the average crystallite size (SFMO) was determined to be approximately 174 nm. After doping, a phase transition takes place due to the Jahn-Teller effect. Scanning electron microscopy (SEM) was employed to examine the surface morphology and grain characteristics. ImageJ software was used to calculate an average grain size of ~20 nm. Optical properties were investigated using UV–Visible spectroscopy, which provided a band gap range of 4.07- 4.23 eV.

Overall, Sr_2FeMnO_6 material exhibits potential characteristics for use in Photocatalytic, spintronic, and multifunctional devices.

Keywords: *Double perovskite, XRD, SEM, Band gap, Multifunctional devices*.

ICAPST-2026-AMNS-488309

Study of Ultra-sensitive GnP-TiO_2 Composite-Based NH_3 Sensor

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ABSTRACT

In the present study, we have developed an interdigitated electrode (IDE) based Graphene nanoplatelet (GnP) and GnP-TiO_2 composite NH_3 gas sensor operated at room temperature. Firstly, for the synthesis of GnP, tea extract used as a green alternative without the use of organic solvents using a kitchen mixer, whereas TiO_2 and GnP-TiO_2 were prepared via a simple hydrothermal process. An IDE-based chemiresistive sensor of GnP and GnP-TiO_2 was tested for NH3 detection over a wide concentration range of 100 ppb to 100 ppm at room temperature. The GnP-TiO_2 composite exhibited a response nearly eight times higher than that of the GnP sensor at 100 ppm NH_3. Additionally, the GnP sensor exhibited response and recovery times of 249 and 107 s, respectively, whereas the GnP-TiO_2 composite achieved 15 and 30 s, corresponding to ~17 fold faster response time and ~3.5 fold quicker recovery at 100 ppb NH_3. Overall, the study advocate the applicability of grown GnP-TiO_2 based composite for NH_3 sensing application in the ppb level concentration.

Keywords: *Green Synthesis, Graphene nanoplatelet, Flower-like TiO_2, NH_3 sensor*

ICAPST-2026-AMNS-502332

Computational Study on Selective H_2O_2 Synthesis via Two-Electron Oxygen Reduction on Functionalized Carbon Quantum Dots

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ABSTRACT

Carbon quantum dots (CQDs) functionalized with suitable groups present a promising approach to achieve selective hydrogen peroxide (H_2O_2) production via a two-electron oxygen reduction reaction (ORR). In this study, density functional theory (DFT) calculations at the B3LYP/def2-TZVP level were used to investigate the ORR mechanism on a CQD model functionalized with COOH and OH groups at edge positions. Functionalization was found to substantially enhance O_2 binding, shifting the adsorption energy from a weakly favorable 0.26-0.31 eV on the pristine cluster to a strongly favorable -1.11 eV at edge sites, while narrowing the HOMO-LUMO gap from 2.52 eV to 2.28 eV, indicating increased electron donating character. Mapping the free energy profile revealed a sequence of exothermic steps—CQD reduction, O_2 addition, and proton-coupled electron transfer—leading to a stable CQD–OOH^- intermediate that serves as the branching point between two and four electron pathways. Transition state analysis, validated by single imaginary vibrational frequencies, showed that peroxide (HO_2^-) formation via C–OOH bond cleavage proceeds with a lower activation barrier (+0.28 eV) than hydroxide formation via CO–OH cleavage (+0.40 eV). These findings establish a kinetic basis for the high H_2O_2 selectivity observed on functionalized CQDs and provide design principles for carbon-based electrocatalysts in sustainable H_2O_2 synthesis.

Keywords: *H_2O_2 synthesis, Oxygen reduction reaction, Carbon quantum dots, Density functional theory*

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Converting *Morus alba* Leaf Waste into Flaxseed-Reinforced Eco-Friendly Biocomposites

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ABSTRACT

In this study, novel reinforced bioactive biocomposites were synthesized using waste *Morus alba* leaves as the primary raw material, glycerol as a plasticizer, corn starch as a filler and flaxseed as a reinforcing agent in varying proportions (1.0 g, 2.0 g, and 3.0 g). Fourier Transform Infrared Spectroscopy (FTIR) analysis of the synthesized sheets establishes hydrogen bonding among the components. Additionally, X-ray Diffraction (XRD) and Scanning Electron Microscopy (SEM) confirm the amorphous nature and rough surface of the sheets, respectively. The optimal physicochemical and barrier properties were achieved by the sheet formulation MCF-2, which consists of waste *Morus alba* leaves, corn starch, and flaxseed in a 3:3:2 ratio. The synthesized sample, MCF-2 demonstrated the lowest water content (5.33 ± 0.52%), water absorption (69.01 ± 0.76%), water solubility (50.86 ± 0.89%), alcohol solubility (43.58 ± 0.17%). Additionally, sample, MCF-2 exhibited the highest biodegradability among all synthesized samples, achieving a remarkable degradation rate of 84.61 ± 2.03%. The synthesized biocomposites also displayed significant antimicrobial and antioxidant activities. These combined bioactive properties, along with superior physicochemical stability and rapid biodegradability, establish *Morus alba* leaf waste-derived biocomposites as viable and sustainable alternatives for active food packaging applications.

Keywords: *Waste Morus alba Leaves, Biocomposites, Antimicrobial activity, Active food packaging, Biodegradability*.

ICAPST-2026-AMNS-508538

Cr-Doped Sr–Zn Aluminate Phosphors: Toward Next-Generation SolidState Lighting

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ABSTRACT

The study represents the structural and optical properties of Cr-doped Sr0.5Zn0.5Al2O4 phosphor prepared by the solution combustion synthesis route using urea as a fuel. A series of samples were prepared keeping the Sr:Zn ratio of 0.5, while Cr concentrations were varied as 0.01, 0.03, 0.05, 0.07, and 0.09. The XRD findings confirmed the coexistence of monoclinic $SrAl_2O_4$ and cubic $ZnAl_2O_4$ phases, with successful incorporation of Cr ions into the host matrix. The average crystalline size shows a general increasing trend as the concentration of Cr is increased. FTIR data confirmed the M-O (M= Cr, Al, Sr, Zn) bonding in the local lattice environment and lattice distortion due to substitution of Al3+ sites by Cr^{3+}. Diffuse reflectance spectra gave the band gap value as 3.00, 2.90, 2.90, 2.88, and 2.84 eV, showing a decreasing trend with increasing Cr concentration. Samples exhibit PL excitation at 420 nm and 533 nm and gave characteristic Cr emission lines in range (675-725 nm), with variation in intensity with change in excitation wavelength. The overall findings indicate that the Cr-doped Sr–Zn aluminates are promising candidates for next-generation red emitting phosphor materials and will be crucial for optimizing LED performance, with superior color rendering and efficiency.

Keywords: *LED, Phosphors, Solution combustion method, Aluminates, spinels*

ICAPST-2026-AMNS-531201

Study of Magnetic-Dielectric Correlation in Gd-Substituted $CoCr_{0.5}Gd_xFe_{1.5-x}O_4$ Spinel Ferrite

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ABSTRACT

Gd-substituted Co-Cr spinel ferrite (GCCF) was synthesized using the Auto-combustion sol-gel method. An investigation of the impact of Gd^{3+} ions on structural, Vibrational, Dielectric, and Magnetic properties was conducted and evaluated as a function of the Gd content. XRD results confirmed the formation of a predominantly spinel structure with space group Fd-3m. The Scherrer formula and Williamson-Hall plots were used to examine the impact of crystallite size and lattice parameter. FTIR spectra exhibited two characteristic absorption bands corresponding to the Tetrahedral and Octahedral metal-Oxygen vibrations. The dielectric constant decreased with increasing frequency, while the AC conductivity increased with increasing frequency. The Vibration Sample Magnetometer analysis confirmed the ferrimagnetic ordering and the variation in M_s, M_r and M_c with Gd^{3+} ($4f^7$) indicate changes in the cation distribution and magnetic exchange interactions. At an applied field of 5000 Oe, magnetization was measured at 5 and 300 K. Overall, Gd substitution effectively tailors the Magnetic, Dielectric, Structural, and Vibrational properties of GCCF ferrites, demonstrating their potential for use in high-frequency magnetic devices.

Keywords: *Spinel Ferrite, XRD, FTIR, Dielectric, VSM, and Sol-Gel Method*

ICAPST-2026-AMNS-543128

β-Cyclodextrin Embedded MXene Sheets Based Electrochemical Assay for Quantification of Luteal Phase Hormone-Progesterone

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ABSTRACT

Progesterone(P4) is an important steroid hormone that plays a crucial role in gestation maintenance, and endocrine regulation, so accurately determining its concentration is of great significance for clinical diagnosis and the evaluation of reproductive health; nevertheless, its low content in physiological samples makes it difficult to detect with high sensitivity. To address these challenges, a chemically processed sensing platform composed of a two-dimensional $Ti_3C_2T_x$ MXene-β-cyclodextrin (MX/CD) composite is reported. XRD, and SEM results also support the formation of composites and improved surface activity. Electrochemical studies by cyclic voltammetry and differential pulse voltammetry over a −0.6-1.6 V potential window showed a well-defined oxidation peak for P4 at about 0.856 V, and the MX/CD-modified electrode exhibited significantly enhanced current responses via an adsorption-controlled process, as evidenced by scan rate studies (R^2 = 0.9836). The insulating property of β-CD is efficiently circumvented by this interface through the utilization of the 2D MXene sheets' high-speed electron-transfer channels. The sensor exhibited a broad linear range of 10 nM – 500 nM; the LOD and LOQ were 0.46 nM and 1.52 nM, respectively. Thus, the MX/CD composite offers a reliable method for improving P4 detection by providing an effective, chemically adjustable, and highly responsive interface for P4 detection.

Keywords: *MXene, Cyclodextrin, Progesterone, Electrochemical Sensor, Supramolecular Chemistry*

ICAPST-2026-AMNS-545617

Structural Characterization and Doping Strategy for Vanadium-Incorporated TiO_2 as a Dilute Magnetic Semiconductor

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ABSTRACT

Dilute magnetic semiconductors (DMS) combine semiconducting and magnetic functionalities, offering a promising platform for spintronic applications. In this study, titanium dioxide (TiO_2) was investigated as a host matrix for vanadium (V) doping to realize a V–Ti–O based DMS system. Pure TiO_2 and V_2O_5 precursor powders were structurally characterized using X-ray diffraction (XRD) with Cu Kα radiation, confirming their crystalline nature through well-resolved diffraction peaks indexed to characteristic (hkl) planes. Crystallite size and microstrain were quantified using the Scherrer equation and Williamson–Hall (W-H) analysis, yielding crystallite sizes of 87.89 nm (TiO_2) and 96.24 nm (V_2O_5), with microstrain values of 0.24×10^{-3} and 1.32×10^{-3}, respectively. Stoichiometric calculations were performed for four V-doping concentrations (1%, 3%, 5%, 7%) via ball-milling, and a complementary one-step and two-step sol-gel synthesis route was formulated for controlled substitutional doping of V into the TiO_2 lattice. This work establishes the structural baseline and synthesis framework necessary for producing V-doped TiO_2 nanoparticles, laying the foundation for subsequent optical and spectroscopic study in this oxide-based DMS system.

Keywords: *Dilute Magnetic Semiconductor, Titanium Dioxide, Vanadium Doping, X-ray Diffraction, Williamson-Hall Analysis, Sol-Gel Synthesis*

ICAPST-2026-AMNS-554799

Cu^{2+}-Mediated Tailoring of Gypsum-Based Biomimetic Material for Radiation and Biomedical Imaging

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ABSTRACT

The development of adaptable biomimetic materials is important for improving experimental studies in biomedical imaging and radiation physics. In the present work, a gypsum-based material was modified with $CuSO_4 \cdot 5H_2O$ to investigate the influence of Cu^{2+} incorporation on its physical, spectroscopic, radiation-interaction, and imaging behaviour. Different compositions were prepared by varying the $CuSO_4$ content, and their response to gamma radiation was examined over a broad photon-energy range. The results show that controlled addition of $CuSO_4$ produces measurable changes in density, attenuation behaviour, effective atomic parameters, photon transmission, and CT response. FTIR measurements further indicate that the basic gypsum structure remains preserved after incorporation of the dopant, with observable changes in the infrared spectral features. The material response was also found to be energy dependent, demonstrating the possibility of adjusting the phantom composition according to the required radiation interaction. The study demonstrates that Cu^{2+} modification provides a simple route for tailoring gypsum-based materials with potential applications in biomedical imaging, radiation dosimetry, phantom development, and medical-physics research.

Keywords: *Cu^{2+} modification; Gypsum biomaterial; Bone phantom; Radiation interaction; Biomedical imaging.*

ICAPST-2026-AMNS-562927

Lead-Free Halide Perovskites: Structure, Photophysical Properties, and Optoelectronic Applications

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ABSTRACT

Lead-free halide perovskites have emerged as promising alternatives to conventional lead-based perovskites for next generation optoelectronic applications. The distinctive compositional diversity and tunable crystal chemistry of these materials offer opportunities for controlling their structural, optical, and electronic properties. This review examines the connection between the compositional and functional properties of lead-free halide perovskites, with particular attention to halide composition and its effect on the photophysical and electronic properties, charge carrier behaviour and overall material stability. Variations in cation and halide composition can influence the band structure and consequently the optical and electronic response of perovskite materials. These characteristics make lead-free perovskites relevant to emerging applications such as photovoltaics, photodetection and light-emitting devices. The review further highlights key challenges associated with defect states, charge transport, synthesis control and reproducible device performance. Further progress is required for improved control over composition for tailoring the properties of these materials. Understanding these structure–property relationships can guide the development of stable and efficient lead-free halide perovskites for future optoelectronic applications.

Keywords: *Lead-Free Halide Perovskites, Crystal Structure, Optical Properties, Optoelectronic Applications*

ICAPST-2026-AMNS-579001

Green-Synthesized ZnO Nanoparticles for Antimicrobial Applications and Sustainable Water Remediation

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ABSTRACT

Zinc oxide (ZnO) nanoparticles are attracting growing interest as multifunctional materials because of their antimicrobial and photocatalytic properties. Green synthesis provides a relatively simple and environmentally friendly approach to producing ZnO nanoparticles using plant-derived extracts, which can assist in nanoparticle formation and stabilization while reducing the use of harsh chemicals. This work highlights the potential of green-synthesized ZnO nanoparticles for antimicrobial applications and sustainable water remediation. Their antimicrobial action involves several complementary mechanisms, including the generation of reactive oxygen species (ROS), release of Zn^{2+} ions, disruption of microbial membranes, and damage to essential cellular components. ZnO also exhibits photocatalytic activity under suitable light irradiation, where electron–hole generation promotes the formation of reactive species that can degrade organic pollutants such as methylene blue. The influence of particle size, morphology, surface properties, pH, catalyst concentration, and irradiation conditions on these processes is discussed. The combined antimicrobial and photocatalytic behaviour of ZnO makes it a promising material for addressing microbial contamination and organic pollutants in water. The study also emphasizes the importance of reproducible green synthesis, safety evaluation, and scalable processing for practical applications.

Keywords: *ZnO Nanoparticles, Green Synthesis, Antimicrobial Activity, Photocatalysis, Water Remediation, Sustainable Nanotechnology*

ICAPST-2026-AMNS-581140

Structural, Spectroscopic, and Optical characterization of Gadolinium-Substituted Mixed nanocrystalline Ferrite for technological uses

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ABSTRACT

Mixed Nickel-Magnesium-Cobalt ferrites, substituted with Gadolinium ($Ni_{0.2}Co_{0.7}Mg_{0.1}Fe_{2-x}Gd_xO_4$, x = 0.02–0.10), were synthesized via the sol-gel auto-combustion method to investigate their structural, spectroscopic, and optical properties. X-ray diffraction (XRD) analysis confirmed the formation of a single-phase cubic spinel structure with lattice parameters varying from 8.3305 to 8.3412 Å as the Gd^{3+} ion content increased, and crystallite sizes ranging from 28–20 nm calculated via the Scherrer equation. The crystalline size and lattice strain of the sample were calculated from the broadening of the XRD peaks using the Williamson-Hall approach. Fourier-transform infrared (FTIR) spectroscopy identified characteristic metal-oxygen stretching bands at 550–600 cm^{-1} and 400–450 cm^{-1}, confirming spinel formation. UV-visible spectroscopy showed a red-shift in the absorption edge, yielding direct bandgaps varying in the range of 3.5-4.5 eV. These tailored properties position Ni-Co mixed ferrites as promising candidates for spintronic devices, high-frequency transformers, and microwave absorbers.

Keywords: *Mixed ferrites, XRD, WH plot, FTIR & UV-Visible*

ICAPST-2026-AMNS-613707

Mechanochemically Activated Synthesis of Nitrogen-Doped $SrTiO_3$ for Visible-Light Photocatalysis

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ABSTRACT

$SrTiO_3$ is a promising perovskite oxide semiconductor for photocatalytic applications due to its excellent chemical stability and suitable electronic properties. In this study, pristine and nitrogen-doped $SrTiO_3$ photocatalysts were successfully prepared using a mechanochemically activated solid-state ball-milling method. Different amounts of HMTA were used as the nitrogen source. The prepared samples were characterized to study their structural, optical, morphological, and elemental properties. XRD analysis confirmed that all the prepared samples retained the cubic crystal structure of $SrTiO_3$ without any impurity phases. Small changes in the diffraction peaks indicated the successful incorporation of nitrogen into the $SrTiO_3$ lattice. UV–Vis DRS showed an absorption edge around 370 nm, with band gap values ranging from 3.15 to 3.21 eV. FESEM images revealed irregular and agglomerated particles, while EDS confirmed the presence of nitrogen in the $SrTiO_3$ structure. The photocatalytic activity of an N-doped sample, prepared by ball-milling of $SrTiO_3$ Powder with 20 wt% HMTA, named STON-20, was evaluated by the degradation of Methylene Blue dye under halogen lamp irradiation. The sample achieved a degradation efficiency of 45.08% after 180 min of irradiation, demonstrating its photocatalytic potential.

Keywords: *$SrTiO_3$, Nitrogen doping, Mechanochemical synthesis, Photocatalysis, Methylene blue degradation.*

ICAPST-2026-AMNS-620923

Unlocking the Morphological Influence on Optical Behaviour of Magnesium Oxide for Radiative Cooling Performance

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ABSTRACT

To alleviate global warming, radiative cooling is one of the state-of-the-art technologies used to cool indoor spaces while mitigating greenhouse gas emissions, carbon footprint, and electricity consumption. It works by reflecting sunlight in the UV-Vis-NIR region and emitting heat through the atmospheric transparency window (ATW) (8-13 μm) into the cold universe (~3 K) attracting considerable attention for passive cooling in building, solar panels, and other thermal management systems. To date, researchers have focused on developing various metal oxide composites (MgO, SiO2, Al2O3, ZnO, ZrO2, and TiO2), but have explored morphological effects on optical and thermal properties only to a limited extent. In this context, we are exploring the effect of MgO morphologies on optical properties and cooling performance. We synthesized different morphologies - spheres, rods, octahedral, and cubes - of MgO nano/micro particles via various synthetic routes, along with their polymer composites. Compared to other structures, MgO octahedral structures show a high reflectance of >95% in the AM1.5 solar spectrum. It is also expected to showcase a high emissivity in the ATW due to phonon polariton resonance, making it a promising candidate for efficient passive daytime radiative cooling applications.

Keywords: *Radiative cooling, Atmospheric Transparency window, Magnesium Oxide, Thermal Emission.*

ICAPST-2026-AMNS-623992

Design and Synthesis of a New Metal-Organic Frameworks (MOFs) For A One-Pot Tandem Deacetalization-Imine Condensation Reaction

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ABSTRACT

Today, almost 90% of chemical products are synthesised by catalytic processes. With the advancement of science and the increasing complexity of molecules, the number of steps to synthesize it also increases. However, multistep syntheses are often energy- and resource-consuming and purification after each step greatly affects the final yield of the product. In one-pot tandem/cascade reactions, two or more sequential or simultaneous reactions proceed inside the same pot. This makes tandem reactions greener and improves the overall yield. However, to catalyse two or more different types of reactions, we require a catalyst containing multiple functional sites. These functional sites often promote synergistic reactions. Metal-organic framework compounds are suitable for designing multifunctional catalytic materials because they are porous and can incorporate multiple functionalities. Two new Zn(II) and Cd(II) based MOFs named **HNBGU-3** and **HNBGU-4** were synthesised. To maximise functionality, multiple linkers (dicarboxylate and bipyridine) were introduced to prepare the new MOFs. Both are efficient heterogeneous catalysts for a one-pot tandem deacetalization-imine condensation reaction under solvent-free conditions, offering a sustainable and atom-economical approach to multistep organic synthesis. The time-dependent kinetic study further revealed that the catalytic efficiency of **HNBGU-3** is higher (Yield ~80%) than that of **HNBGU-4** (Yield ~44%).

Keywords: *Metal-organic frameworks, Tandem catalysis, Organic catalysis, Green reactions.*

ICAPST-2026-AMNS-676255

Study of Structural Properties and Electronic Structure of Pure and Co-doped ZrO_2 Nanoparticles

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ABSTRACT

Pure and Co-doped ZrO_2 nanoparticles were synthesized by the coprecipitation method. The samples were characterized using X-ray diffraction (XRD), Raman spectroscopy, and X-ray photoelectron spectroscopy (XPS). XRD results showed that all samples confirmed a mixed crystal structure consisting of monoclinic and tetragonal phases. With increasing cobalt content, the tetragonal fraction grew at the expense of the monoclinic phase. This indicates that cobalt doping promotes stabilization of the metastable tetragonal structure. Changes in the lattice parameters and a decrease in crystallite size confirmed the substitution of Zr^{4+} by cobalt ions. Raman spectroscopy confirmed these results by identifying the characteristic vibrational modes of both crystal phases. It also showed peak broadening and changes in peak intensity, indicating lattice distortion and the formation of oxygen vacancies caused by cobalt doping. XPS confirmed the chemical states of the constituents, revealing Zr^{4+}, cobalt in the Co^{2+} state, and an O1s envelope resolved into lattice-oxygen and oxygen-vacancy components, whose contributions increased with cobalt content. The results establish cobalt as an effective agent for tuning phase stabilization.

Keywords: *Zirconium dioxide, Coprecipitation, Raman spectroscopy, XPS, Oxygen vacancies.*

ICAPST-2026-AMNS-713522

Defect-mediated dielectric relaxation and nanoscale magnetic domain evolution in Te-doped $BiFeO_3$ ceramics

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ABSTRACT

Multiferroic $BiFeO_3$ (BFO) is attractive for multifunctional devices owing to the room-temperature coexistence of ferroelectric and magnetic ordering, but high leakage current and weak magnetisation limit its application. Here, Te-doped BFO (0–2.0 %) ceramics were synthesised by the sol–gel route and analysed by X-ray diffraction with Williamson–Hall analysis, FTIR, UV–visible diffuse reflectance, FESEM–EDX, impedance spectroscopy and magnetic force microscopy (MFM). XRD confirms the rhombohedral R3c phase with doping-dependent crystallite size, lattice strain and dislocation density, while FTIR shows shifted Fe–O bands of the FeO_6 octahedra and a redshifted band gap indicating Te 5p–O 2p hybridisation and defect states. The dielectric constant decreases from 2200 for pristine BFO at 100 Hz with Te addition, and tanδ falls markedly above 1 kHz, consistent with Maxwell–Wagner interfacial polarisation and suppressed space-charge hopping; impedance analysis reveals non-Debye relaxation with grain and grain-boundary contributions. MFM shows evolution from faint canted-antiferromagnetic contrast to well-defined domains at intermediate doping, attributed to Fe^{3+}/Fe^{2+} double exchange, oxygen-vacancy redistribution and cycloidal spin suppression. The 1.5 % composition offers the best balance of low dielectric loss, frequency stability and magnetic ordering for dielectric, electronic and spintronic devices.

Keywords: *Bismuth ferrite, Tellurium doping, Sol–gel synthesis, Dielectric relaxation, Impedance spectroscopy, Magnetic force microscopy, Oxygen vacancies.*

ICAPST-2026-AMNS-719802

A Paper-Based Label-Free Colorimetric Platform for Point-of-Care Detection of Vitamin C Using $CuCo_2O_4$/CuO Nanocomposites

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ABSTRACT

Rapid, affordable, and accurate detection of biologically relevant analytes is a cornerstone of modern point-of-care (POC) diagnostics, enabling timely clinical decisions independent of centralized laboratory infrastructure. Ascorbic acid (Vitamin C), an indispensable antioxidant, plays a critical role in collagen biosynthesis, immune modulation, and iron metabolism; its deficiency or excess is clinically associated with scurvy, oxidative tissue damage, and metabolic dysregulation. Herein, we report the hydrothermal synthesis of $CuCo_2O_4$/CuO nanocomposites and their deployment as a label-free colorimetric sensing platform for ascorbic acid detection. The nanocomposites were systematically characterized by XRD, UV–Vis spectroscopy, FTIR, DLS, and SEM. XRD analysis confirmed the coexistence of spinel $CuCo_2O_4$ and monoclinic CuO phases, with crystallite sizes in the range of 13–20 nm. The colorimetric sensing mechanism is governed by surface adsorption of ascorbic acid onto the nanocomposite, inducing local dielectric environment variations that modulate the material's optical absorption and scattering properties, generating a visually perceptible response. The optimized platform achieved a limit of detection of 4.27 μM with high selectivity against common interferents. Post-sensing FTIR and SEM analyses corroborated the proposed surface interaction mechanism. Furthermore, a paper-based device prototype was fabricated to demonstrate the translational potential of the sensing system toward practical, field-deployable diagnostics.

Keywords: *Label-free detection, Colorimetric sensing, Point-of-care diagnostics, nanocomposites, Hydrothermal synthesis*

ICAPST-2026-AMNS-736122

Binder-Free In-Situ Hydrothermal Growth of NiO Thin Films on FTO Substrates for Smart Electrochromic Supercapacitor Electrodes

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ABSTRACT

This work focuses on the binder-free fabrication of nickel oxide (NiO) thin films directly on fluorine-doped tin oxide (FTO) substrates for multifunctional electrochromic and supercapacitor applications. NiO thin films were synthesized using a single-step in-situ hydrothermal method, in which the FTO substrate was directly immersed in an aqueous reaction bath containing the nickel precursor. This approach enables simultaneous nucleation and growth of NiO nanostructures on the FTO surface without the use of binders or additional powder-processing steps. The synthesized films were characterized using X-ray diffraction (XRD), field-emission scanning electron microscopy (FESEM), and Fourier-transform infrared (FTIR) spectroscopy. XRD confirmed the formation of phase-pure cubic NiO, while FESEM revealed a uniform nanostructured morphology favourable for electrolyte penetration. FTIR confirmed the characteristic Ni–O vibrational modes. The direct growth of NiO provides strong adhesion and intimate electrical contact with the FTO substrate, facilitating efficient charge transfer. The developed method is simple, cost-effective, and scalable, offering a promising route for the fabrication of NiO/FTO electrodes for smart electrochromic supercapacitor devices.

Keywords: *NiO thin film, In-situ hydrothermal synthesis, FTO substrate, Nanostructured electrode, Electrochromic supercapacitor.*

ICAPST-2026-AMNS-737750

First Principles Study of $CeOs_4As_{12}$ Filled Skutterudite

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ABSTRACT

Filled skutterudite compounds are a promising candidate for spintronic, thermoelectric and optoelectronic applications due to their unique cage-like crystal structure which allows guest atoms for suppression of lattice thermal conductivity without affecting the electronic transport. Despite extensive studies on filled skutterudites, the cerium (Ce) filled arsenic (As) skutterudite ($CeOs_4As_{12}$) remains partially characterized. It has a body-centered cubic (BCC) crystal structure and lies to the $Im\bar{3}$ space group. The present work aims at investigating the electronic structure, band gap and density of state of $CeOs_4As_{12}$ via density functional theory (DFT) with the full-potential linearized augmented plane wave (FP-LAPW) method using WEIN2k software. The Birch-Murnaghan equation provided the equilibrium configuration with cell volume of ≈2160 a.u.^{3} and ground-state energy of -210253.08 Ry. Also, the density of states reached ~91 states/eV at +0.13 eV. Moreover, the predicted band structure and density of states shown a direct band energy gap of ≈0.67eV. A maximum value of real optical conductivity (≈1.24×10^4 $\Omega^{-1}cm^{-1}$) is achieved at 3.9 eV. ZT values close to 0.5 at 900K suggests that appropriate p- or n-type doping could yield favourable thermoelectric performance. Such outcomes establish $CeOs_4As_{12}$ compound as a structurally ($Im\bar{3}$ phase) and mechanically stable candidate for real-life application implementation.

Keywords: *Filled Skutterudites, First Principles, Thermoelectric Devices, Density Functional Theory (DFT).*

ICAPST-2026-AMNS-739561

Photocatalytic degradation of Methylene Blue dye using Cr_2O_3/MoS_2/PANI

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ABSTRACT

Aquatic ecosystems and human health are at grave risk due to the growing amount of wastewater that is tainted with dyes. Photocatalytic degradation is a practical and sustainable way to efficiently remove persistent organic pollutants from wastewater. In this work, Cr_2O_3/MoS_2/PANI ternary nanocomposite was developed for photocatalytic breakdown of methylene blue (MB) dye. The synthesized composite was characterized using XRD, FTIR, FE-SEM, and EDX, and its photocatalytic ability was assessed with UV-visible spectrophotometry. The improved photocatalytic degradation performance is due to the synergistic interactions and efficient heterointerfacial contact among Cr_2O_3, MoS_2, and PANI, which allow charge-carrier separation and migration, reducing electron-hole recombination. A consistent and regulated degradation pathway was shown by the remarkable 72.136 % degradation efficiency attained in 180 min. The proposed composite shows great promise for effective treatment of dye-contaminated wastewater.

Keywords: *Nanocomposite, Dye degradation, Photocatalytic degradation, Wastewater*

ICAPST-2026-AMNS-745047

Structural Crystallinity, Functional Group Analysis and Optical Behaviour of $ZnFe_2O_4$ Ferrite Nanoparticles Prepared by Green Sol-Gel Method

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ABSTRACT

Zinc ferrite ($ZnFe_2O_4$) is a technologically important spinel ferrite that has attracted considerable attention owing to its excellent structural stability, nanoscale particle size, and tunable optical properties. These characteristics make $ZnFe_2O_4$ nanoparticles promising candidates for applications in photocatalysis, chemical sensing, and advanced electronic devices. In the present study, $ZnFe_2O_4$ nanoparticles were successfully synthesized through an eco-friendly green sol–gel method using metal nitrates as precursor materials and natural citric acid (lemon) as a chelating agent, followed by gelation, drying, and calcination. The structural characteristics of the synthesized nanoparticles were investigated using X-ray diffraction (XRD), which confirmed the formation of a single-phase cubic spinel structure. Fourier transform infrared (FTIR) spectroscopy was employed to identify the characteristic functional groups and confirm the formation of the spinel lattice through prominent metal–oxygen vibrational bands corresponding to tetrahedral and octahedral sites. Furthermore, the optical properties were investigated using UV–Visible spectroscopy, which revealed tunable optical absorption characteristics and band-gap energies. The obtained results demonstrate that the green sol–gel approach is an effective and sustainable route for the synthesis of $ZnFe_2O_4$ nanoparticles with controllable structural and optical properties, highlighting their potential for targeted multifunctional technological applications.

Keyword: *Ferrite, Green Synthesis, XRD, FTIR*

ICAPST-2026-AMNS-779814

High-Efficiency Lead-Free $CsSnI_3$ Perovskite Solar Cells Enabled by WS_2 and Cu_2O Selective Transport Layers

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ABSTRACT

Lead-free inorganic tin-based perovskites, specifically $CsSnI_3$, have emerged as a potential replacement for traditional lead halide absorber materials because they are environmentally friendly, have a suitable bandgap, and enable relatively good charge-carrier transport. In this research, we used SCAPS-1D for numerical modeling and optimization of an FTO/WS_2/$CsSnI_3$/Cu_2O/Au heterojunction perovskite solar cell. We evaluate and analyze the impact of the thickness of the $CsSnI_3$ absorber, concentration of acceptors (N_A), bulk defects in it (N_t), temperature (T), series resistance (R_s), and shunt resistance (R_{sh}) on the efficiency of the cell expressed in terms of V_{oc}, J_{sc}, FF, and PCE. The thickness optimization alone gave a PCE of 25.58% at the best thickness of 1.4 μm. However, with the N_A equal to 10^{21} cm^{-3} it becomes possible to increase the built-in potential and, consequently, obtain the maximum theoretical PCE, which is 35.96% (V_{oc}=1.2462 V, J_{sc}=32.19 mA/cm^2, FF=89.69%). The analysis of defect density and temperature sensitivities emphasizes the importance of controlling SRH recombination and parasitic resistance to attain high efficiency. The suggested lead-free device design offers a sustainable, eco-friendly approach to photovoltaic technology and can help produce clean energy while reducing dependence on toxic lead-containing solar materials.

Keywords: *Perovskites, Lead halide, Bandgap, Bulk defects, Series resistance, Defect density*

ICAPST-2026-AMNS-782731

Development of an Electrochemical Biosensor Based on Fe–Ni MOF and Conducting Polymer Composites on Carbon Cloth for Early Cancer Biomarker Detection

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ABSTRACT

Cancer continues to be one of the leading causes of death worldwide, and for many malignancies, the biggest obstacle to survival isn't the disease itself but how late it's caught. This makes sensitive, low-cost biosensing platforms for early biomarker detection a genuinely urgent need, not just an academic exercise. In this work, we designed and built a hybrid electrochemical biosensor using an iron–nickel metal–organic framework (Fe–Ni MOF) deposited on carbon cloth, chosen for its flexibility and inherent conductivity. To push the electron transfer kinetics further, we combined the MOF with a conducting polymer, which gave us a composite with noticeably better charge transport and structural stability than the MOF alone.Our main goal here was to show that Fe–Ni MOF/carbon cloth composites can actually work as a sensing platform for clinically relevant cancer biomarkers — a proof of concept rather than a finished device. Through synthesis, surface functionalization, and characterization, we confirmed that the MOF deposits uniformly and reproducibly across the carbon cloth substrate, with the kind of morphology and structure you'd want for a biosensor. Pairing the porous MOF network with the conducting polymer creates an interface that boosts the electrochemical signal and gives analytes more accessible surface area to interact with.

For detection, we relied primarily on electrochemical impedance spectroscopy (EIS), since it's highly sensitive to small changes in interfacial charge-transfer resistance when an analyte binds to the electrode surface — exactly the kind of subtle shift this platform needs to pick up on. We also used cyclic voltammetry (CV) and differential pulse voltammetry (DPV) alongside EIS to cross-check the sensing response and get a more complete picture, both qualitatively and quantitatively, of what's happening at the electrode.

This work sets the stage for flexible, next-generation diagnostic devices for early cancer detection, and we're now working toward full biosensor validation and quantification of actual biomarker levels.

Keywords: *Fe-Ni MOF, Carbon Cloth, Electrochemical Biosensor, CA 19-9, Antigen-Antibody Interaction, Impedance Spectroscopy.*

ICAPST-2026-AMNS-785170

Influence of Na_2O on Lithium Bismuth Silicate Glasses: Structural and Physical Properties

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ABSTRACT

In this work, bismuth silicate glass matrix with mixed alkali in the composition $xNa_2O\cdot(25-x)\ Li_2O\cdot 25Bi_2O_3\cdot 50SiO_2$ ($0 \le x < 20$ mol%; NLBS) was prepared using the melt-quench process. The amorphous nature of every sample was validated by XRD examination. The substitution of Li^+ ions with Na^+ ions caused non-linear compositional differences in density, molar volume, and oxygen packing density. A structural reorganization of the glass network is suggested by the decrease in interionic distance (R_i) and polaron radius (R_p) as well as the increase in field strength (F). The presence of SiO_4, BiO_3 and BiO_6 units, Bi–O–Si connections and the creation of non-bridging oxygens shown by FTIR analyses, suggesting that Na_2O actively contributes to the modification of the silicate network. These results show that the structural development and physical characteristics of the studied glasses are significantly influenced by the mixed alkali effect.

Keywords: *Bismuth silicate glasses, Mixed alkali effect, Density, FTIR, XRD.*

ICAPST-2026-AMNS-800803

From Biomolecular Building Blocks to Functional Bionanozymes: Enzyme-Mimetic Activity, Molecular Recognition, and Therapeutic Applications

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ABSTRACT

The Natural peroxidase (POD) enzymes, despite high efficiency, suffer from high cost, limited stability, and narrow operational windows, motivating robust biomimetic alternatives. Here, a vitamin B9-Cu (VB9-Cu) bionanozyme is introduced, featuring a biomolecule-defined coordination environment that facilitates electron transfer and reactive oxygen species (ROS) generation, enabling strong peroxidase-like activity. The bionanozyme follows Michaelis-Menten kinetics (K_m = 0.570 mM; V_{max} = 7.53 × 10^{-5} mM s^{-1}). This activity enables colorimetric dopamine detection over 0-200 μM with a detection limit of 20.32 nM. Smartphone integration enables portable detection with a limit of 92.48 nM, demonstrating potential for point-of-care diagnostics. Vitamin B9 provides receptor-mediated targeting, promoting selective cancer-cell uptake. Under tumor-relevant conditions, VB9-Cu catalyzes intracellular H_2O_2 conversion to cytotoxic •OH radicals, inducing oxidative stress-mediated apoptosis. The bionanozyme exhibits an IC50 of 160.09 μg mL^{-1} in HeLa cells, while maintaining 51.1% viability in HEK cells at 400 μg mL^{-1}. Overall, VB9-Cu integrates catalysis, molecular targeting, biosensing, and chemodynamic therapy within a modular platform for point-of-care sensing and precision nanomedicine. The Cu(I)/Cu(II) redox cycle promotes H_2O_2 activation and •OH generation, supporting efficient catalysis and therapeutic efficacy under relevant conditions.

Keywords: *Bionanozyme, Catalysis, Sensing, Targeting, Chemodynamic therapy*

ICAPST-2026-AMNS-801088

Design, Synthesis, Spectroscopic Characterization and DFT Calculations of Hybrid Dibutyltin (IV) Complexes of 4-Acyl Pyrazolone and Carboxylate Ligands

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ABSTRACT

The present study deals with the synthesis and structural characterization of four hybrid dibutyltin(IV) complexes of general formula $\{Bu_2SnL_{(n)}A\}$. These complexes were synthesized by the reaction of sodium salts of substituted pyrazolones ($L_{(n)}H$) and carboxylic acid (AH) with dibutyltin dichloride in a 1:1:1 molar ratio in refluxing dry tetrahydrofuran. The synthesized coloured solid complexes were soluble in common organic solvents. A six-coordinate geometry has been proposed for the newly synthesized complexes with the assistance of vibrational (IR) and magnetic resonance (^1H, ^{13}C, ^{119}Sn NMR) spectroscopies. A bidentate nature of both the ligands was revealed by spectroscopic studies. Mass spectrometry shows the monomeric nature of the synthesized dibutyltin (IV) complexes. Additionally, Density Functional Theory (DFT) calculations were carried out using the B3LYP functional and a basis set to get structural and energy insights into the synthesized complexes. The DFT results provide valuable insights into the optimized molecular structures, energy levels, stability, and any distortions in the structural parameters of these hybrid complexes.

Keywords: *Dibutyltin (IV) complexes, 4-Acyl pyrazolones, Carboxylic acid, DFT, Optimized molecular structure*

ICAPST-2026-AMNS-814596

In Vitro Growth-Driven Si/ZnO/HfO_2 Heterostructures for Enhanced Electron Mobility

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ABSTRACT

Wide-bandgap oxide semiconductors are gaining increasing attention for next-generation electronic and optoelectronic platforms, including thin-film transistors, photo-transistors, non-volatile memories, inverters, and chemical sensors. Oxide materials based on In, Ga, and Zn already enable advanced display technologies such as AMOLED and AMLCD owing to their wide bandgap, high electron mobility, and strong excitonic response. In this work, we demonstrate a controlled internal oxidation strategy to convert a buried metallic Zn layer into ZnO underneath a sputtered HfO_2 overlayer on n-type Si substrates. Structural analysis via X-ray diffraction confirms complete oxidation of Zn and formation of a ZnO/HfO_x stack ($x < 2$), while X-ray photoelectron spectroscopy reveals oxygen non-stoichiometry within HfO_2, validating oxygen migration into Zn during annealing. Low-temperature photoluminescence (4 K) further supports high crystalline quality through sharp near-band-edge emission at ~3.37 eV. Importantly, this buried oxidation route enables heterojunction engineering for mobility enhancement in ZnO-based thin-film transistor channels. A 44 nm Zn layer converted in situ beneath HfO_2 on n-Si generates a sharp Si/ZnO interface, producing band bending and a triangular potential well that supports electron accumulation similar to a two-dimensional electron gas, thereby boosting mobility.

Keywords: *Heterostructure, Photoluminescence Spectroscopy, Photo-transistor, Thin-film Transistor.*

ICAPST-2026-AMNS-817435

Solvothermal Synthesis and Defect Engineering of WO_3 Nanostructures for High-Performance Supercapacitors

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ABSTRACT

In this report a hydrothermal defect-engineering strategy for tungsten oxide (WO_3) to enhance its electrochemical performance as an emerging capacitive energy-storage material. WO_3 nanostructures were synthesized hydrothermally from a sodium tungstate (Na_2WO_4) precursor under controlled pH and temperature conditions, enabling systematic modulation of oxygen-vacancy concentration and crystallographic defects. Variations in solvothermal parameters tune defect density, which in turn governs electronic conductivity, active-site availability, and ion-diffusion pathways. X-ray diffraction, X-ray photoelectron spectroscopy, and electron paramagnetic resonance confirm oxygen vacancies and W^{5+} states that promote reversible W^{6+}/W^{5+} redox activity. In a 1 M H_2SO_4 electrolyte (three-electrode configuration), defect-engineered WO_3 delivers a specific capacitance of up to 600 F g^{-1} at 1 A g^{-1}, significantly higher than that of pristine WO_3 synthesized under standard conditions. The material exhibits quasi-rectangular cyclic voltammograms and nearly symmetric galvanostatic charge–discharge profiles, indicating a hybrid capacitive mechanism combining electric double-layer and faradaic pseudocapacitance. Electrochemical impedance spectroscopy reveals reduced series and charge-transfer resistances in defect-rich WO_3, consistent with improved charge transport and interfacial kinetics. This work demonstrates that hydrothermal defect engineering provides a scalable, one-pot route to tailor WO_3 for high-performance capacitive energy-storage devices, highlighting defect-guided design as a key strategy for next-generation transition-metal-oxide electrodes.

Keywords: *Defect engineering, Solvothermal, WO_{3-x}, Hybrid supercapacitor*

ICAPST-2026-AMNS-849471

Engineering Lead-Free Multiferroic Composites for Enhanced Magneto-electric Performance: Roles of Composition and Sintering Conditions

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ABSTRACT

This work presents a systematic study of lead-free multiferroic composites of $(x)Co_{(1+y)}Ti_yFe_{2(1-y)}O_4$–$(100-x)BaTiO_3$, which were synthesized by a solid-state reaction method to investigate the effects of composition and sintering temperature on their structural, electrical, magnetic, and magneto-electric (ME) properties. XRD analysis confirms the presence of both ferroelectric and ferromagnetic phases. FESEM depicts the formation of homogeneous composites. Saturation magnetization is found to increase with increasing ferric content; moreover, an increase in sintering temperature also increases the M_S of each sample. *P-E* loops confirm the ferroelectric nature of all composites, and the E_C is found to depend upon the CTFO content as well as sintering temperature. The dielectric constant decreases and the loss tangent increases with increasing CTFO content, as well as the inter-ferroelectric transitions of $BaTiO_3$ (BTO) diffuse. The composite 30CTFO-70BTO sintered at 1200°C exhibits the largest ME coupling ($\alpha \sim 1.28$ mV/cm.Oe) at low frequency. Our results show that, in addition to the relative phases of CTFO/BTO in these composites, sintering temperature plays an important role in controlling their electrical and magnetic properties. They also demonstrate the potential of lead-free composites for multifunctional device applications in next-generation, low-power technologies, magnetic field sensors, spintronic devices, and actuators.

Keywords: *Multiferroic, Magneto-electric coupling, Ferroelectric, Ferromagnetic, Dielectric*

ICAPST-2026-AMNS-870805

Quercetin-Functionalized Coconut Shell-Derived Activated Carbon for Sensitive Electrochemical Detection of Dopamine Toward Early Parkinson's Disease Diagnosis

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ABSTRACT

Parkinson's disease is a progressive neurological disorder that damages brain cells responsible for producing dopamine (DA), primarily affecting movement, balance, and coordination. Although no cure currently exists, medications, therapies, and surgical options can effectively manage symptoms and significantly improve quality of life. Accurate monitoring of DA is therefore essential for the early diagnosis and management of Parkinson's disease. In this work, a sustainable electrochemical sensor based on quercetin-functionalized coconut shell-derived activated carbon (Q-CSAC) was developed for the sensitive detection of dopamine. Activated carbon was synthesized from coconut shell via H_3PO_4 activation and characterized by scanning electron microscopy (SEM) and X-ray diffraction (XRD), confirming the successful development of a porous carbon framework with favorable electrochemical properties. The synergistic combination of conductive activated carbon and redox-active quercetin significantly enhanced the electrocatalytic oxidation of dopamine. Electrochemical measurements performed over a potential window of −0.2 to 0.6 V exhibited a well-defined oxidation peak at 0.24 V. Using square wave voltammetry (SWV), the sensor displayed a wide linear response range from 10 nM to 200 µM, with a limit of detection (LOD) of 0.15 nM and a limit of quantification (LOQ) of 0.48 nM. The fabricated sensor demonstrated excellent selectivity against common interfering biomolecules, along with outstanding repeatability, reproducibility (RSD < 5%), and long-term stability. The proposed CS-QR sensor offers a simple, low-cost, and environmentally friendly platform for dopamine determination, highlighting its potential for clinical diagnostics and early monitoring of Parkinson's disease.

Keywords: *Dopamine detection, Activated carbon, Quercetin, Electrochemical sensor, Parkinson's disease, Square wave voltammetry*

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Influence of CdS Incorporation on Fractal Surface Morphology and Acetone Sensing of TiO_2 Thick Films

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ABSTRACT

Fractal geometry provides an effective approach for correlating the surface morphology of gas-sensing films with their sensing performance.The effect of CdS incorporation into TiO_2 thick films on their fractal characteristics and acetone-gas sensing properties was investigated. TiO_2 and CdS–TiO_2 composite films were characterized using atomic force microscopy (AFM), and fractal dimension, Hurst exponent, and surface roughness were evaluated from AFM images.

The sensing performance was studied for 5000 ppm acetone at low operating temperatures. Among the samples, the 2 wt% CdS–TiO_2 film exhibited the highest sensing response of 71%, with a response time of 27 s and a recovery time of 75 s. The Hurst exponent analysis showed that the 2 wt% CdS film exhibited persistent surface growth ($H > 0.5$), indicating a memory effect during deposition, whereas films with lower CdS concentrations showed anti-persistent behavior ($H < 0.5$). The variation in Hurst exponent and grain size with CdS concentration demonstrates that doping significantly influences surface morphology and fractal characteristics. The experimental results agree with theoretical models, confirming the relationship between fractal surface parameters and gas-sensing performance. The study shows that fractal analysis can help optimize surface morphology and improve semiconductor gas-sensor performance.

Keywords: *Fractal dimensions; Hurst exponent; sensing performance; Acetone gas; CdS-TiO_2 thick film.*

ICAPST-2026-AMNS-872796

Synthesis-Route-Dependent Structural and Electrochemical Properties of Co_3O_4 Nanoparticles

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ABSTRACT

The synthesis route plays a crucial role in tailoring the structural and functional properties of nanomaterials. In this study, the influence of different synthesis methods on the structural, morphological, and electrochemical properties of Co_3O_4 was systematically investigated. Co_3O_4 nanoparticles were synthesized using three distinct approaches: sol–gel auto-combustion (CSG), co-precipitation (CCP), and hydrothermal (CHT) routes. XRD analysis confirmed the formation of pure-phase Co_3O_4 in all samples. The crystallite size, estimated using the Debye–Scherrer equation and Williamson–Hall (W–H) analysis, revealed that the CCP sample possessed the smallest crystallite size (~19 nm). FTIR and Raman spectroscopy identified characteristic vibrational modes, further confirming the spinel structure of cobalt oxide. FESEM images showed nanoscale grains in the range of 27–58 nm, with distinct morphological variations highlighting the strong influence of the synthesis route on particle growth. Energy-dispersive X-ray (EDX) analysis verified the elemental composition along with uniform elemental distribution. Electrochemical measurements carried out in a 3-electrode configuration using 6M KOH electrolyte demonstrated superior capacitive performance of the CCP electrode, delivering a high specific capacitance of 872 F g^{-1} at 5 mV s^{-1}, along with an energy density of 14.72 Wh kg^{-1} and power density of 825 W kg^{-1}.

Keywords: *Sol-gel auto-combustion method, Co-precipitation, Hydrothermal, Electrochemical performance, Energy density, Power density.*

ICAPST-2026-AMNS-888373

Synthesis, structural, morphological and photoluminescence properties of ilmenite $CdSnO_3$ nanoparticles

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ABSTRACT

In this work, rhombohedral ilmenite-type cadmium stannate ($CdSnO_3$) nanoparticles were synthesized by chemical co-precipitation via thermal decomposition of synthesized $CdSn\text{-}3H_2O$ at an annealing temperature of 850°C. The obtained powder was characterized by X-ray diffractometry (XRD), field-emission scanning electron microscopy (FE-SEM), transmission electron microscopy (TEM), FT-IR spectroscopy, UV-Vis spectrophotometry, photoluminescence (PL), and thermogravimetric analysis/ differential scanning calorimetry (TGA/DSC). XRD patterns confirmed that the synthesized $CdSn\text{-}3H_2O$ nanoparticles have a cubic structure with a crystalline size 23nm. $CdSnO_3$ shows a pure ilmenite rhombohedral phase, and the average crystallite size of the nanoparticles was found to be 25.6. FE-SEM studies indicated that the nanoparticles have a porous cubic morphology. FT-IR spectra showed characteristic peaks confirming $CdSnO_3$ formation. UV-Vis spectrophotometry revealed that the absorption edge shifted towards a lower wavelength. The optical band gap of $CdSn\text{-}3H_2O$ and $CdSnO_3$ was found to be 4.8 eV and 3.1 eV, respectively. The PL spectrum confirmed that CdSnO3 nanoparticles calcined at 850 °C show defect-related visible emission. The TGA analysis confirms that $CdSnO_3$ achieves thermal stability in the range of 750 °C to 900 °C. Such remarkable properties of ilmenite $CdSnO_3$ are considered for potential applications in gas sensing and photocatalysis.

Keywords: *Ilmenite $CdSnO_3$, XRD, Photocatalysis, FT-IR, TGA*.

ICAPST-2026-AMNS-908655

A Comprehensive Review on Cellulose-MOF-Based Functional Material for Wastewater Treatment

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ABSTRACT

Organic dyes, heavy metals, drugs, and emerging pollutants continue to enter water sources, harming both humans and the environment. We need long-term solutions. Recently, researchers have developed a new type of functional material called cellulose-MOF adsorbents. These materials combine the biodegradability, large surface area, and adjustable functionality of cellulose with the ultrahigh porosity, adjustable pore chemistry, and catalytic versatility of MOFs in a single, effective material. These include π-π stacking, hydrogen bonding, electrostatic attraction, and chelation. The focus is on integrating MOFs into different cellulose matrices, such as nanocellulose, bacterial cellulose, and cellulose aerogels, and on how these approaches affect mass transfer, recyclability, and stability (e.g., in situ growth, covalent grafting, and physical embedding). These trends include 3D-printed designs, stimulus-responsive cellulose-MOFs, and hybrid systems that combine polymers and nanoparticles. In conclusion, we propose directions for further research to bridge the gap between theoretical performance and practical wastewater treatment, focusing on more sustainable synthesis, enhanced selectivity, and integration into continuous flow systems. This review shows how cellulose-MOF functional materials could change wastewater treatment by making it more effective, long-lasting, and flexible.

Keywords: *MOFs, Dyes, Adsorbent, Cellulose, Chelation.*

ICAPST-2026-AMNS-918784

Green Sol–Gel Synthesis of Nanocrystalline $MgFe_2O_4$ Ferrite Using Lemon-Derived Citric Acid

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ABSTRACT

Magnesium ferrite ($MgFe_2O_4$) nanoparticles are promising soft magnetic materials with extensive applications in magnetic storage, microwave devices, catalysis, and optoelectronics. In this study, $MgFe_2O_4$ nanoparticles were synthesized via a sustainable green sol–gel route using metal nitrates as precursors and fresh lemon (*Citrus limon*) extract as a natural chelating agent. Structural characterization via X-ray diffraction (XRD) confirmed the formation of a single-phase cubic spinel nanocrystalline structure, with crystallinity increasing as a function of optimized synthesis conditions. The average crystallite size, determined using both the Debye–Scherrer and Williamson–Hall methods, ranged from ~5 to 85 nm, demonstrating the tunability of the nanostructure through processing parameters. Additionally, UV–Visible spectroscopy was employed to evaluate the optical absorption profiles of the synthesized nanoparticles. These results confirm the efficacy of lemon extract as a viable, eco-friendly reagent for fabricating functional ferrite nanomaterials, offering a sustainable alternative for advanced technological applications.

Keywords: *Nanocrystalline, Green Synthesis, Ferrite, XRD*

ICAPST-2026-AMNS-925680

A bifunctional electrocatalyst based on f-CNT-doped mesoporous $PdCu_3$ nanocubes for Pb^{2+} monitoring and water splitting

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ABSTRACT

Electrochemical sensing and electrocatalysis using advanced nanomaterials have emerged as promising strategies for environmental monitoring and energy applications due to their enhanced sensitivity, selectivity, and stability. In this work, palladium-copper nanocubes ($PdCu_3$ NCs) with a Pd:Cu ratio of 1:9 were synthesized via a facile one-pot solvothermal approach and integrated with functionalized carbon nanotubes (f-CNTs) at 5 and 10 wt% loadings. Structural and morphological analyses confirmed the formation of uniformly distributed $PdCu_3$ nanocubes on the f-CNT surface, resulting in increased active sites and improved electron transfer efficiency. The electrochemical performance was evaluated using a modified glassy carbon electrode. Among the modified electrodes, the 5% f-CNT/$PdCu_3$/GCE exhibited the best sensing response toward Pb^{2+} ions in phosphate-buffered saline (pH 5), achieving a low detection limit of 1.98 nM along with good stability, repeatability, and selectivity against interfering species. Furthermore, the 5% f-CNT/$PdCu_3$/GCE demonstrated efficient bifunctional electrocatalytic activity for the water splitting reaction, achieving low overpotentials of 0.107 V for hydrogen evolution and 0.138 V for the oxygen evolution reaction at 10 mA cm^{-2}. Favorable Tafel slopes further confirmed fast reaction kinetics. These results highlight the potential of this nanocomposite as a multifunctional platform for sensing and energy conversion.

Keywords: *f-CNT doped $PdCu_3$ nanocubes, Electrochemical Sensor, Lead ions, Hydrogen Evaluation Reaction, Oxygen Evaluation Reaction.*

ICAPST-2026-AMNS-939235

Plectranthus amboinicus-modified ZnO nanoflorets for dual-function water purification: A potent green catalyst for efficient dye degradation and antibacterial defense

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ABSTRACT

Textile industries face sustainability issues because they produce large amounts of wastewater polluted with dyes. A broad spectrum of photocatalysts has been formulated to break down dyes, aiming to reduce the chemicals and energy needed to treat dye-contaminated wastewater. Multiple spectroscopic and analytical methods, including XRD, UV-Vis, FTIR, TGA, SEM, and EDS, confirm the formation of biomodified ZnO nanoparticles. The ideal conditions for photocatalytic degradation were 10 ppm, pH 7.8, 25 mg catalyst, and 120 minutes of contact time. In scavenger experiments, hydroxyl radicals were identified as the main reactive species responsible for MB degradation. Real water matrices serve as a source of MB dye pollution, show minimal interference, and achieve degradation similar to the deionized water experimental setup. Six cycles of catalytic activity do not significantly change the percentage degradation, and the structural stability and efficiency of green-synthesized ZnO are unaffected. The synthesized ZnO NPs also show strong antibacterial activity and can therefore be used in wastewater treatment.

Keywords: *ZnO nanoflorets, Green synthesis, Plectranthus amboinicus, Antibacterial activity, Photocatalysis*

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Mg-Al-Ga-based double spinels: Cation ordering and luminescence study

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ABSTRACT

Double spinel oxides, as novel oxide materials, offer application versatility because cations distribute across tetrahedral/octahedral sublattices, making them potential candidates for lighting applications. In this study, we synthesized novel $MgAlGaO_4$ double spinels by combustion synthesis, varying the fuel between urea and citric acid. Comparing experimental and simulated X-ray diffraction patterns helped confirm the presence of cation-disordered arrangements in both samples. X-ray absorption spectroscopy at the Ga, Mg, and O *K*-edges helped elucidate how synthesis conditions affect the local electronic structure of the core elements. Band-gap analysis revealed that the samples have a wide band gap in the range 5.45-5.59 eV. The photoluminescence spectroscopy, upon excitation at 250 nm, exhibited wide emission in the near-infrared region, spanning between 625-800 nm, centered at 715-720 nm, attributed to radiative transitions between oxygen interstitials deep defect states and cation vacancy/antisite shallow defects arising due to disordered mixed spinel configuration. The results open promising avenues for in-depth investigation of cation-ordering-related structural modifications and their subsequent effects on the material's optical properties.

Keywords: *Simulated XRD, Photoluminescence, X-ray absorption spectroscopy, Combustion synthesis*

ICAPST-2026-EAS-121838

Synthesis and Characterization of NPK-Loaded Cellulose-Based Hydrogel from Arecanut Husk and Its Effects on Soil Properties and Maize (*Zea mays L.*) Growth

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ABSTRACT

Increasing agricultural waste and sustainable water management have prompted the synthesis of biodegradable hydrogels for agricultural applications. The current work aimed to synthesize NPK-loaded cellulose hydrogel from Arecanut (*Areca catechu L.*) husk and assess its suitability for enhancing early growth of maize (*Zea mays L.*). Cellulose was prepared via alkaline, acid, and bleaching treatments to strip off lignin and hemicellulose contents. Characterization of the prepared cellulose was done using FTIR and HR-SEM analysis, which confirmed successful extraction of non-cellulosic substances and produced cleaner and rougher surface of cellulose fibrils that is ideal for hydrogel formation.

Grafting of cellulose with acrylic acid was done using APS as the initiator and MBA as the crosslinker. Among the four formulations, H4 proved superior with gel fraction of 89.98%, swelling ratio of 1315.84%, reswelling capacity of 2483.72%, and water holding capacity of 67.44%. Hydrogel loaded with 4% of NPK solution had a swelling capacity of 1705.68% due to high fertilizer-retaining ability. From pot studies, hydrogel treatments enhanced germination of maize with hydrogel-alone treatment registering maximum germination of 81.48% and germination index of 4.04. Based on the results obtained, the synthesized NPK-loaded cellulose hydrogel shows a great promise as an eco-friendly soil conditioner.

Keywords: *Arecanut husk, Cellulose, NPK-loaded hydrogel, Soil moisture retention, Sustainable agriculture.*

ICAPST-2026-EAS-130162

Defect Engineering and Interface Chemistry in Biohybrid Systems: Emerging Design Strategies for Advanced Environmental and Energy Applications

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ABSTRACT

The development of sustainable materials through biohybrid design using renewable biopolymers and functional inorganic nanomaterials is gaining increasing attention as a strategy for environmental remediation, carbon capture, catalysis, and energy storage. Although much progress has been made, understanding of the relationship between interface chemistry and defect engineering remains insufficient. This review discusses recent developments in interface engineering and defect regulation in selected biohybrids, such as biochar-metal oxides, cellulose-MOF, lignin-based carbons, and polymer-nanometal composites. The review emphasizes the importance of interfacial interactions, which govern electron/ionic transport, molecular adsorption, and stability. However, deliberately designed defects, such as oxygen vacancies, heteroatom doping, and framework vacancies, help tailor the materials' electronic structure, create active sites, and increase catalytic efficiency. It has been shown by several recent reports that the combined effect of the engineered interfaces and defects contributes to the improved performance of charge separation, adsorption properties, redox capabilities, photocatalytic degradation, carbon dioxide capture, and electrochemical energy storage. The review covers the latest approaches to rationally designing defect-functionalized biohybrid structures and the major challenges associated with defect management and interface stability.

Keywords*: Biohybrid materials, Interface chemistry, Defect engineering, Interfacial charge transfer, Oxygen vacancies, Environmental remediation, Sustainable catalysis.*

ICAPST-2026-EAS-155024

Bioremediation of toxic dyes from water using iron oxide nanoparticles loaded lichen biomass

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ABSTRACT

The various hazardous dyes viz. methylene blue (MB), crystal violet (CV), methyl orange (MO), congo red (CR) are entering into the water bodies from the effluents of paper, printing, textile, dyeing, food, rubber, pharmaceutical industries and research laboratories. These dyes are well recognized mutagen and having carcinogenic properties. The aim of this study was exploitation of locally available lichen specially Parmotrema sp. in removal of various toxic dyes like MB, CV, MO, CR from water and a detailed understanding of its adsorption.

Parmotrema sp. was collected from Tehri-Garhwal region, Uttarakhand. The collected bioreagent was utilized to biofrabricate iron oxide nanoparticles (IONPs). The IONPs loaded/free bioreagent (10 mg) was exposed to 10 mL (pH-7) aqueous solution of MB, CV, CR, MO separately for 240 min at room temperature. Their efficacy in removal of toxic dyes from water was measured by UV-VIS Spectrophotometer. It was observed that both IONPs loaded/free lichen are capable to remove cationic dyes from water. However, they couldn't eliminate anionic dyes from water.

Therefore, it can be said that lichen (IONPs loaded/free) is a potential bioreagent for removal of cationic toxic dyes from water and it can be exploited for waste water treatment in future.

Keywords: *Lichen, Iron Oxide nanoparticles, toxic dyes, Water Treatment*

ICAPST-2026-EAS-159244

Sustainable Carbon Quantum Dots for Climate-Resilient Agriculture: A Comprehensive Review

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ABSTRACT

This review examines the synthesis, characterization, and agricultural applications of carbon quantum dots (CQDs) derived from agricultural waste biomass. Carbon quantum dots are carbon-based nanoparticles smaller than 10 nm with distinctive photoluminescence, high water solubility, low toxicity, excellent biocompatibility, and tunable optical properties that enable their utilization in sustainable agricultural systems.

CQDs are predominantly synthesized through hydrothermal, microwave-assisted, and pyrolytic approaches, utilizing agricultural residues such as rice husk, banana peel, sugarcane bagasse, and coconut shell as sustainable carbon precursors. Specific synthesis methodologies include hydrothermal, microwave-assisted, and pyrolytic approaches, and key quantitative characterization findings include particle size 2-10 nm, quantum yields (5- 80%), surface properties, and optical characteristics.

The characterized CQDs demonstrate multifaceted agricultural applications including enhanced seed germination rates (20-40% improvement), improved nutrient use efficiency through nanofertilizer delivery systems, smart pesticide delivery with reduced chemical losses, and fluorescent nanosensors for detection of heavy metals, pathogens, and soil nutrients. Additionally, CQDs enhance plant stress tolerance against drought and salinity through amplified antioxidant activity, while supporting soil health monitoring applications.

This review highlights that biomass-derived CQDs synthesized through optimized methods and characterized through rigorous analytical techniques represent promising materials for precision agriculture and climate-resilient farming systems aligned with circular bioeconomy principles.

Keywords: *Biomass, Agricultural waste, Climate-resilient, Sustainable agriculture, Nanomaterials.*

ICAPST-2026-EAS-169817

DEVELOPMENT OF SILVER-GRAPHENE OXIDE FOR ENVIRONMENTAL APPLICATIONS

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ABSTRACT

For advanced multifunctional materials for sustainable remediation, the growing concerns of microbial contamination and environmental pollution have created a demand. This work focuses on the development of a silver-graphene oxide (Ag-GO) hybrid membrane with combined antimicrobial and environmental remediation capabilities. The membrane was designed by integrating silver nanoparticles onto graphene oxide, utilizing the high surface area and adsorption capacity of graphene oxide along with the broad – spectrum antimicrobial properties of silver. The synthesized Ag-GO membrane was characterized using FTIR, XRD, and FESEM-EDX to evaluate its structural and functional properties. Antimicrobial activity was tested against selected Gram-positive and Gram-negative bacteria; the membrane exhibited inhibition zones of 2mm against E.coli and 4mm against S. aureus, confirming enhanced antimicrobial activity through the synergistic action of silver nanoparticles and graphene oxide. Additionally, the membrane exhibited 96% removal of Alizarin red dye among the six tested dyes, demonstrating high adsorption efficiency. The enhanced antimicrobial performance, pollutant removal efficiency, and stability of the membrane highlight its suitability for water treatment and environmental applications. The developed Ag-GO membrane represents a cost-effective and sustainable approach for addressing challenges associated with microbial contamination and environmental pollution, offering significant potential for applications in public health, water purification, and environmental protection.

Keywords: *Silver-graphene oxide, Antimicrobial applications, Environmental remediation, Pollutant removal efficiency, Water treatment.*

ICAPST-2026-EAS-244928

Multi-Response Optimization of Microwave Pyrolysis for Sustainable and Efficient Conversion of Orange Peel into Highly Porous Functional Carbon

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ABSTRACT

In this study, orange peel is converted into highly porous carbonaceous orange peel char (OPC) through a microwave pyrolysis route. The effect of three process parameters, viz. Microwave Power, Microwave Exposure Time, and Particle Size were studied on OPC yield, its carbon content, and BET surface area. All the process parameters were found to significantly affect all three outputs. These three process parameters were optimized using Response Surface Methodology for maximizing OPC yield, its carbon content, and BET surface area. A regression model was developed for each of the three outputs. Higher Fischer test values and lower p-values of these regression models ensured higher reliability of these regression models. The developed regression models showed excellent agreement with the experimental data. The model predicted OPC char yield, carbon content, and BET surface area of 63.7%, 78.4%, and 918.7 m2/g, respectively. The experimentally obtained values for OPC char yield, carbon content, and BET surface area were 66.2%, 74.3%, and 881.4 m2/g, respectively, with deviations of 3.77% in OPC yield, 5.22% in carbon content, and 4.06% in BET surface area. Thermal and chemical characterization of OPC was also done using TGA, FT-IR, and XRD.

Keywords: *Functional Carbon; Microwave pyrolysis; Orange Peel; RSM optimization: Waste Velarization.*

ICAPST-2026-EAS-375452

Eco-Friendly Synthesis of TiO_2@CeO_2 Core–Shell Heterostructures for Enhanced Visible-Light Photocatalytic Remediation of Organic Pollutants and Automobile Wastewater

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ABSTRACT

Pure TiO_2 and CeO_2 nanoparticles, as well as TiO_2@CeO_2 and CeO_2@TiO_2 core-shell heterostructures, were synthesized using a clean sol-gel approach and thoroughly characterized. XRD confirmed the anatase phase of TiO_2 and the FCC fluorite structure of CeO_2, with crystallite sizes ranging from 10.61 to 14.59 nm. XPS showed that Ti^{4+}, Ce^{3+}, and Ce^{4+} are active in forming the heterostructure. FESEM and HRTEM showed that the spherical nanoparticles have well-defined core-shell interfaces. The material in the core-shell structure had low bandgaps with better visible light absorption (e.g., with PL quenching), while the electron-hole recombination was suppressed. BET analysis showed a mesoporous Type IV/H3 structure, with TiO_2@CeO_2 having the largest surface area of 46.866 m^2/g. Under visible light, TiO_2@CeO_2 demonstrated excellent photocatalytic activity, degrading Methyl Red to very low concentrations (k = 0.01647 min^{-1}) within 60 minutes and photomineralizing real automobile wastewater in 180 minutes (k = 0.00544 min^{-1}). Hydroxyl (•OH) radicals and photogenerated holes were identified as the dominant reactive species. Overall, the TiO_2@CeO_2 heterojunction facilitates charge separation and interfacial transfer, making it an effective photocatalyst for the removal of industrial wastewater.

Keywords: *Core-shell nanoparticles, Heterojunction, Photocatalysis, Methyl Red degradation, Automobile wastewater, Visible light.*

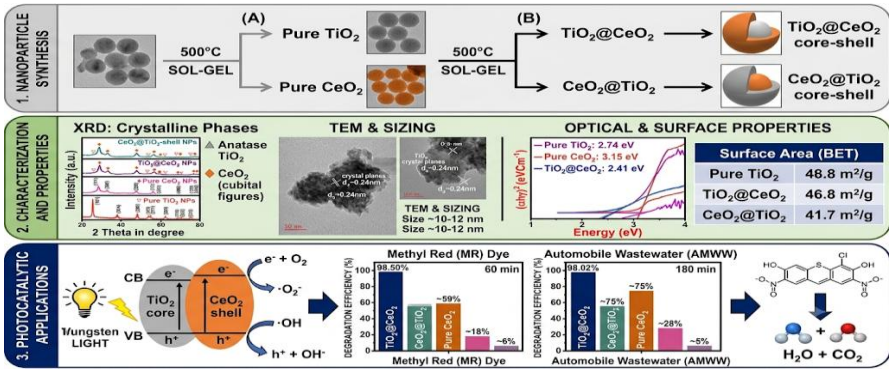


Figure: Synthesis of TiO_2@CeO_2 core-shell nanoparticles for photodegradation of mR dye and AMWW samples under visible light irradiation.

ICAPST-2026-EAS-485078

Optical Investigation of Dielectric and Plasmonic Core–Shell Nanoparticles for Light Management

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ABSTRACT

Core–shell nanoparticles have attracted considerable attention for their potential in optical light management and optoelectronic applications owing to their tunable scattering, absorption, and resonance properties. In this work, the optical properties of both dielectric–dielectric and dielectric–metal core–shell nanoparticles are investigated using Mie scattering theory. TiO_2@SiO_2 and ZnS@SiO_2 are considered as dielectric core–shell structures, while TiO_2@Ag and ZnS@Ag are investigated as metal nanoshells with TiO_2 and ZnS as the dielectric cores and silver (Ag) as the shell materials. The embedding medium for the nanoparticles is considered to be the hole transport layer (PEDOT: PSS). The scattering and absorption efficiencies are calculated using Mie theory implemented in MATLAB. The influence of core diameter, shell thickness, shell material, and refractive-index contrast on the optical response is systematically analyzed. The results demonstrate that in dielectric–dielectric structures, the optical response is primarily governed by Mie resonances and enhanced light scattering, whereas dielectric–metal nanoshells exhibit pronounced surface plasmon resonance arising from the metallic shells. The comparative analysis of dielectric and metal nanoshells provides valuable insight into their distinct light–matter interaction mechanisms and highlights their potential for applications in light trapping, photon management, solar cells, LEDs, and other advanced optoelectronic devices.

Keywords: *Nanoparticles, Scattering, Optical, Resonance.*

ICAPST-2026-EAS-523588

Statistical Investigation of Coronal Mass Ejection (CME) Properties Across Solar Cycles 23 and 24

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ABSTRACT

This study presents a statistical analysis of 29,488 Coronal Mass Ejections (CMEs) observed by SOHO/LASCO during Solar Cycles 23 and 24 (1996–2018). The study examines CME angular width, latitude, speed, acceleration, mass, energy, and their correlations. CME widths showed a bias toward lower values and varied with solar activity. The latitudinal distribution exhibited poleward expansion during the rising phase and narrowing during the declining phase. A strong north–south asymmetry was observed in Solar Cycle 24, with 67% of CMEs originating from the northern hemisphere. CME speeds were generally low, with higher average and maximum speeds in Solar Cycle 23; maximum speeds were 3387 km/s and 3163 km/s in Cycles 23 and 24, respectively. About 94% of CMEs had accelerations between −100 and +10 m/s², with faster CMEs showing greater deceleration. CME mass and energy were also lower in Solar Cycle 24, with average values of approximately 1.07×10^{15} g and 1.3×10^{30} erg, respectively. Overall, the results reveal significant differences in CME characteristics between the two solar cycles and their dependence on solar activity.

Keywords: *Sun, CME, Angular width, Linear speed*

ICAPST-2026-EAS-528683

Assessment of heavy metal contamination in Kasaragod, Kerala

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ABSTRACT

Endosulfan was extensively applied through aerial spraying in eleven panchayats of Kasaragod district for several decades to control tea mosquito bugs in cashew plantations. Over time, residents of these areas began reporting a wide range of chronic health conditions. Although several investigations have been conducted, the findings have not conclusively established endosulfan as the sole cause of these health problems, suggesting that other environmental factors may also have played a role.

Among the possible contributors, heavy metals and naturally occurring radionuclides have attracted considerable attention because of their persistence and toxicity. Elements such as lead (Pb), chromium (Cr), nickel (Ni), arsenic (As), cobalt (Co), zinc (Zn), manganese (Mn), copper (Cu), and iron (Fe) can accumulate in soil. Prolonged exposure to these elements has been associated with several disorders.

In this study, the concentrations of these elements were determined using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). Human health risks were evaluated by estimating the Average Daily Dose (ADD), Hazard Quotient (HQ), Hazard Index (HI), Cancer Risk (CR), and Total Cancer Risk (TCR) for ingestion, inhalation, and dermal exposure pathways in both children and adults. The estimated risk values were found to remain within the recommended safety limits.

Keywords: *Endosulfan, Heavy metals, ICP-OES, USEPA.*

ICAPST-2026-EAS-594454

FUNCTIONALISED BIOCHAR FOR SUSTAINABLE CARBON SEQUESTRATION AND IMPROVED SOIL HEALTH IN SUPPORT OF PLANT GROWTH

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ABSTRACT

The urgent need for sustainable carbon sequestration solutions that boost agricultural output has been brought to light by rising concentration of atmospheric carbon dioxide caused by human activity. To promote soil health and increase CO2 capture, this study explores production of amine-functionalized biochar from coconut shell waste. Pyrolysis was used to create coconut shell biochar, chemically activated with phosphoric acid and functionalized with triethylamine and epichlorohydrin to add amine groups with a high affinity for CO_2. BET, XRD, DLS, zeta potential, PL, FE-SEM, and EDX were used to analyse produced biochar, confirming improved surface characteristics, increased porosity, and successful amine functionalization. Effects of soil amendment trials employing clay loam soil and 5% by weight concentration of functionalized and activated charcoal (FAB) on crop performance and soil health were assessed. Growth, photosynthetic rate, and root architecture were evaluated using green gram, a nitrogen-fixing and amendment-sensitive crop. Compared to control, biochar-amended soil showed increased porosity, total organic carbon, and water-holding capacity. FAB showed increased CO_2 sequestration in both pot and lab settings. By acting as both carbon sink and soil conditioner, it provides a scalable, affordable, and environmentally friendly way to improve crop yield, soil resilience, and carbon capture under climate change.

Keywords: *Biochar, sustainable agriculture, CO_2 sequestration, Total organic carbon, Water Holding Capacity, porosity.*

ICAPST-2026-EAS-715787

Circular Economy Strategies for Sustainable Municipal Solid Waste Management: Challenges and Opportunities

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ABSTRACT

The Rapid growth of urban populations, changing consumption patterns, and industrialization have significantly increased municipal solid waste (MSW) generation worldwide. Traditional linear waste management models based on the take-make-dispose approach have proven inadequate due to increasing environmental degradation, resource depletion, and greenhouse gas emissions. The circular economy (CE) concept offers a sustainable alternative by promoting waste prevention and reuse. Recycling and resource recovery. This paper examines the integration of circular economy principles into municipal solid waste management systems and evaluates their potential to improve resource efficiency and environmental sustainability.

This study reviews circular economy strategies for municipal solid waste management, including source segregation, recycling, composting, anaerobic digestion, waste-to-energy, and extended producer responsibility. It examines implementation barriers and emerging opportunities, highlighting their potential to reduce landfill dependence, enhance resource recovery, support climate action, and advance SDGs 11,12 and 13.

Keywords*: Circular Economy, Municipal Solid Waste, Resource Recovery, Recycling, Waste Valorization, Sustainable Development Goals.*

ICAPST-2026-EAS-889697

Synthesis, characterization, and dual-function remediation performance of an activated carbon–polyaniline (AC-PANI) nanocomposite for textile effluents

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ABSTRACT

In this study, an activated carbon–immobilized polyaniline (AC-PANI) multifunctional composite was engineered via an in situ chemical oxidative precipitation route for water decontamination. Comprehensive structural and surface analyses employing Fourier-transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), transmission electron microscopy (TEM), and zeta potential profiling confirmed successful polymeric anchoring, high surface functionality, and favorable interfacial charge distribution. Batch adsorption investigations showed that the AC-PANI matrix exhibited rapid dye-uptake kinetics, with removal dynamics governed by solution pH, contact time, and adsorbent mass loading. The synergistic interplay between the mesoporous carbon backbone and the electroactive polyaniline chains facilitated robust mass transfer and strong surface-complexation phenomena. Significantly, the composite maintained high uptake stability across five successive regeneration–adsorption cycles, demonstrating excellent mechanical and chemical durability. Concurrently, the material displayed pronounced antimicrobial efficacy against pathogenic bacterial strains, preventing surface biofouling during treatment. With its facile fabrication, cost efficiency, structural resilience, and dual decontamination capability, the AC-PANI composite presents a highly viable, scalable candidate for sustainable wastewater remediation.

Keywords: *AC-PANI Composite, Polyaniline Immobilization, Textile Dye Sequestration, Adsorption Kinetics, Reusability, Antimicrobial Activity.*

ICAPST-2026-EAS-904570

Valorization of Banana Plant Waste into a Cellulose-Based Hydrogel and Its Effects on Soil Properties

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ABSTRACT

A cellulose-based hydrogel, a type of biodegradable biopolymer, was synthesized from banana plant waste with the aim of developing an eco-friendly soil conditioner. Cellulose was extracted through sequential alkaline, acid, and bleaching treatments, and its functional groups were characterized using Fourier Transform Infrared (FTIR) spectroscopy. FTIR analysis confirmed the successful removal of hemicellulose and lignin, indicating the purity of the extracted cellulose. The synthesized hydrogel was prepared via free radical polymerization, incorporating acrylic acid as the monomer, ammonium persulfate as the initiator, and N, N′ methylenebisacrylamide as the cross-linker. The gel fraction ranged between 80.42% and 85.29%, with an average of 82.23%, demonstrating efficient crosslinking. The swelling ratio showed substantial water absorption capacity, indicating the hydrogel's suitability for soil moisture retention. When applied to soil, the hydrogel significantly improved soil physical properties. Water holding capacity (WHC) increased from 33.62% in bare soil to 77.93% in soil mixed with 0.54 wt% hydrogel. The soil porosity also increased, promoting better aeration, while the bulk density decreased, enhancing root penetration and soil structure. These improvements suggest that the synthesized cellulose-based hydrogel has great potential as a sustainable material to improve soil quality and water retention, especially in water-scarce agricultural regions.

Keywords: *Banana waste, Cellulose, Superabsorbent hydrogel, Soil conditioners, Water retention*

ICAPST-2026-EAS-918657

Identification and Characterization of Microplastics in Sewage Sludge

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ABSTRACT

Sewage sludge, a byproduct of wastewater treatment processes, is utilized in agriculture as an organic amendment due to its richness in essential nutrients and organic matter. Sludge enhanced the soil fertility but it contains various contaminants, including the emerging pollutants such as microplastics (MPs). Microplastics, which are defined as particles smaller than 5mm, attracted considerable attention because of their persistence, potential for accumulation in agricultural soils, and harmful impacts on soil health, microbial communities, plant growth, and the wider environment**.** In this context, the current research revealed that the average amount of MPs particles in sewage sludge was 218.50 ± 46.43 MPs/g of dry wt. The microplastic sizes varied from 0.045mm to 5mm, of which the size in the range of 0.1- 0.25mm was dominant in sewage sludge. The shape of microplastics was mainly in the form of fibers and fragments. Colours of MPs was also observed and the results showed that black, transparent, blue, and white were the dominating colours. MPs polymer composition was determined using ATR-FTIR and the results indicated that polypropylene (PP), polyethylene (PE), and polyethylene terephthalate (PET) was found mainly in sludge.

Keywords*: Microplastics, Sludge, Environment, Size, Shape, Polymer.*

ICAPST-2026-EAS-974086

Comparative analysis of Elemental abundance ratios, Oxygen ion charge state ratio and Average ionic charge states in shock-ICMEs and non-shock-ICMEs and their geomagnetic impact for solar cycle 23

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ABSTRACT

This study presents a statistical analysis of the ionic charge-state properties and elemental abundance ratios of 277 interplanetary coronal mass ejections (ICMEs) observed during solar cycle 23 (1998–2009), including 154 ICMEs associated with shocks (shock-ICMEs) and 123 ICMEs not associated with shocks (non-shock-ICMEs). Using the disturbance storm time (Dst) index, the study explores the connection between ICME plasma composition and geomagnetic storm (GS) intensity. Elemental abundance ratios **(Fe/O, Mg/O, and Si/O**), the oxygen charge-state ratio (**O^{7+}/O^{6+}**), and average ionic charge states (**avqO, avqMg, avqFe, and avqSi**) are examined using distributional comparisons and Spearman rank correlations. While non-shock-ICMEs are typically linked to weak storms, shock-ICMEs are more commonly linked to moderate and severe GSs. The elemental abundance ratios indicate no statistically significant link with Dst between shock-ICMEs and non-shock-ICMEs, suggesting that Fe/O, Mg/O, and Si/O are unreliable storm intensity indicators in the current dataset. In contrast, **O^{7+}/O^{6+}**, avqO, avqMg, avqFe, and avqSi exhibit significant negative correlations with Dst for shock-ICMEs, whereas avqO, avqMg, avqFe, and avqSi exhibit significant negative correlations for non-shock-ICMEs. In non-shock-ICMEs, the highest correlations are observed for avqFe ($\rho = -0.402$, $p = 7.13 \times 10^{-1}$) and avqSi ($\rho = -0.344$, $p = 1.49 \times 10^{-1}$).

Keywords: *Interplanetary Coronal Mass Ejection, Geomagnetic Storms, Elemental Abundance Ratios, Solar Cycle 23*

ICAPST-2026-EPIS-149001

Beyond Sensitivity: Nonlinear Detection-Threshold and Fabrication-Tolerance Analysis of Palladium-Loaded One-Dimensional Photonic-Crystal Hydrogen Sensors

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ABSTRACT

Palladium-loaded one-dimensional photonic crystals enable electrically passive, spark-free hydrogen monitoring. An analytically benchmarked transfer-matrix solver compares a Pd layer buried in a half-wave defect cavity with a surface-Pd Tamm resonator on the same Si/SiO_2 Bragg platform. A zero-normalised Pd-H loading law is anchored to the reported response of a Pd-on-mirror device; the absolute values therefore remain model-based. With an assumed incident-referenced 60 dB amplitude-noise floor, the Tamm resonator is about 685-fold more sensitive in mean wavelength shift, but the calculated nonlinear 3σ wavelength thresholds are 1.197 vol.% for the Tamm design and 1.532 vol.% for the cavity. Fixed-wavelength intensity interrogation gives thresholds of 0.050 and 0.809 vol.%, respectively. For independent 2% rms layer-thickness errors, the cavity provides a 0.16 nm usable flank against 24.2 nm simulated 2σ scatter, whereas the Tamm design provides 83.6 nm against 38.8 nm. A bulk-equilibrium van 't Hoff model places the 4 vol.% plateau crossing near 42.9 °C, subject to thin-film confirmation. These comparative calculations show that sensor ranking must combine nonlinear calibration, resonance contrast, linewidth, readout modality, fabrication tolerance, gas access, and temperature; they do not constitute an experimentally established limit of detection or safety certification.

Keywords: *Photonic crystal, Tamm plasmon, Hydrogen sensor, Transfer matrix method, Model-based detection threshold, Palladium*

ICAPST-2026-EPIS-195154

Resonant-state expansion for non-relativistic wave equation in one dimension

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ABSTRACT

The resonant state expansion (RSE), a rigorous perturbation theory recently developed in electrodynamics, is here applied to the non-relativistic wave equation in one dimension. The resonant states (RSs) of a symmetric double quantum well structure superimposed by a combination of delta functions were first calculated. These RSs are then taken as an unperturbed basis for the RSE. The resonant state expansion is first verified for triple quantum well systems, showing convergence to the available analytic solution as the number of basis resonant states increases. The method is then applied to more complicated systems such as multiple quantum well and barrier structures. Results are compared with the Eigen solution in triple quantum wells and infinite periodic potentials, revealing the nature of the resonant states in the studied systems.

Keywords: *Unperturbed Resonant States, Wave equation, Eigen Solutions, Convergence*

ICAPST-2026-EPIS-350938

Effect of Pressure on Electronic Properties of B1 and B2 Phases of BaO using DFT

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ABSTRACT

After simulating the ground states of B1 and B2 phases of BaO applying the Linear Combination of Atomic Orbitals method within the framework of density functional theory, the electronic design descriptors are calculated. The three design descriptors, namely the pressure dependent band gap (E_g), volume deformation potentials α_p and β_p, and the branch point energy (E_{BPE}) are reported. Both B1and B2phases have a direct band gap at X and Γpoint respectively. No change in the nature of the band gap is observed on applying pressure. In the B2 phase, a decrement in the band gap with pressure is observed up to 95 GPa. The branch-point energy lies close to the conduction band in both compounds, indicating a conducive electronic environment for unipolar doping.

Keywords: *Branch point energy, LCAO, Pressure, Volume deformation Potential.*

ICAPST-2026-EPIS-402750

IoT-Enabled Smart Energy Management System for Sustainable Buildings: Toward AI-Integrated Renewable Energy Solutions

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ABSTRACT

Rising electricity demand coupled with stagnant generation capacity has created an acute energy crisis in commercial and institutional buildings worldwide. This paper presents a cost-effective, IoT-based Smart Energy Management System (SEMS) designed to reduce electricity wastage through intelligent, sensor-driven automation. The proposed system integrates a bi-directional people counter using infrared (IR) sensors, passive infrared (PIR) motion detectors, a Light Dependent Resistor (LDR), a Grove temperature sensor, SPDT relays, Arduino UNO microcontrollers, NodeMCU (ESP8266 Wi-Fi module), a Wi-Fi-enabled smart energy meter, and cloud-based platforms including ThingSpeak and the SmartLife mobile application. The system autonomously switches room appliances — including air conditioners, fans, and lights — based on occupancy, ambient temperature, and light intensity, while enabling real-time remote monitoring and control via smartphone. Results demonstrate significant potential for energy conservation in educational and commercial institutions. The paper also discusses AI- and LoRaWAN-based future enhancements that could make such systems integral components of renewable energy ecosystems and smart grid infrastructure, contributing to environmental sustainability.

Keywords: *Smart Energy Management, Smart Metering, Renewable Energy, Environmental Sustainability, Building Automation*

ICAPST-2026-EPIS-406446

Bio-Inspired Self-Powered Optoelectronic Devices for Artificial Vision

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ABSTRACT

Artificial retina systems require highly integrated, low-power, and fast optoelectronic sensors capable of mimicking retinal neurons. Here, we report a hybrid-dimensional 0D Buckminsterfullerene (C60)/2D ReSe2 nanosheets-assembled 3D heterostructure fabricated via sol-gel synthesis for neuromorphic artificial retina applications. The device exhibits significantly enhanced zero-bias photocurrent, reaching improvements of approximately 16500%, 6667%, 4695%, 13030%, and 64328% under 365, 456, 532, 632, and 850 nm illumination, respectively, compared with pristine ReSe2. Remarkably, wavelength-dependent tuning enables a bidirectional photoresponse, with negative signals at 365–456 nm and positive signals at 532–850 nm. This behavior originates from the synergistic interplay between the photothermoelectric effect in C60 and the photovoltaic effect in ReSe2. The self-powered wavelength-tunable response enables emulation of cone and bipolar cell functions and their hierarchical connectivity within a single device platform. These results demonstrate strong potential for neuromorphic vision and next-generation artificial retina systems.

Keywords: *Neuromorphic vision, Artificial retina, 0D/2D Hybrids, C60/ReSe₂ Heterostructure, Bidirectional, Self-Powered.*

ICAPST-2026-EPIS-530659

Optical spectra of BP and GaP using linear response time-dependent density functional theory

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ABSTRACT

The optical spectra of zincblende BP and GaP are calculated within the framework of time-dependent density functional theory. The ground state is achieved using local density approximation. On the top of the ground state the random phase approximation and adiabatic local density approximation kernels are applied to explore the optical behaviour. The peaks in the spectra of the imaginary part of the dielectric function are attributed to the interband transitions specified by the bands dispersion diagram. The high frequency dielectric constants, the real and imaginary part of the refractive index, and the reflectivity are reported for both compounds. The results when compared with the experimental and other available findings show very good agreement. In addition, the local field effect is also included to analyze the optical spectra.

Keywords: *Adiabatic local density approximation, BP, GaP, Linear response time-dependent density functional theory, Optical properties, Random phase approximation.*

ICAPST-2026-EPIS-634772

High-Sensitivity and Flexible Organic Thin-Film Transistor (OTFT) Sensor Functionalized with BDTTTBA Ligand for Selective Detection of Pb^{2+} Ions

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ABSTRACT

This work reports the advance of a high-potential, flexible, and affordable organic thin-film transistor (OTFT) sensor explicitly planned for the sensitive sensing of lead (Pb^{2+}) ions. The device uses a pentacene active layer (25 nm) on a SiO_2 (300 nm)/Si substrate, deliberately functionalized with the ligand 4,4',4",4'"(benzo[1,2-b:4,5-b']dithiophene-2,4,6,8-tetrayl)tetrabenzoic acid (BDTTTBA). The integration of the BDTTTBA ligand onto the pentacene surface enables strong coordination with Pb^{2+} ions, inducing important variations in the device's electrical features. Prior to detection, the OTFT exhibited a field-effect mobility of 0.37 cm^2/Vs, a threshold voltage (V_{th}) of -5.81 V, and an on/off current ratio of 4.2 x 10^4. Upon exposure to Pb^{2+} ions, a distinct modulation in performance was observed, with the mobility reduced to 0.197 cm^2/Vs, V_{th} shifting to -2.35 V, and the on/off ratio adjusting to 2.9 x 10^4, signifying a clear sensing response. This work reveals that the working together between the BDTTTBA receptor and the pentacene semiconductor affords a vigorous platform for real-time heavy metal monitoring, uniting the advantages of organic electronics such as mechanical flexibility and ease of fabrication with the high sensitivity required for environmental and health safety applications.

Keywords: *Tetrabenzoic acid, Organic Thin-Film Transistor, Mobility, Threshold Voltage and Sensor.*

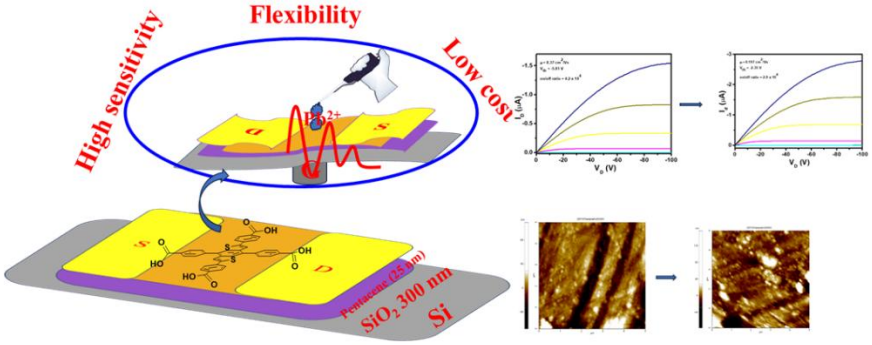


Figure: Surface-tuned organic thin-film transistor-based sensor for sensitive and selective detection of Pb^{2+} ions.

ICAPST-2026-EPIS-778277

A comparative study of Quantum noise handling techniques

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ABSTRACT

Noise is a major limitation in near-term quantum computing, affecting the accuracy and reliability of quantum simulations. In this work, we investigate the performance of the Weighted Subspace-Search Variational Quantum Eigen solver (WSSVQE) for a three-qubit Ising-type Hamiltonian in the presence of bit-flip noise. WSSVQE is employed to simultaneously estimate the ground and excited-state energies using a hardware-efficient ansatz and the COBYLA optimizer. To improve the accuracy of energy estimation, three complementary noise-handling techniques—Pauli Twirling, Zero-Noise Extrapolation (ZNE), and Quantum Error Correction (QEC) using a three-qubit bit-flip code—are implemented and systematically compared with the unmitigated case. The noise probability is varied from 0% to 10%, and the performance is assessed through energy, energy error, fidelity, purity, concurrence, and energy-spectrum analysis. The results demonstrate that Pauli Twirling and ZNE effectively reduce the impact of bit-flip noise, while QEC provides enhanced robustness at higher noise levels. The study highlights an integrated WSSVQE-based framework for improving the reliability of eigenvalue estimation and quantum simulations on noisy quantum devices.

Keywords: *Quantum Computing, WSSVQE, Pauli Twirling, Quantum Error Correction*

ICAPST-2026-EPIS-820724

Robust Continuous-Variable Multipartite Entanglement Using Arrays of Nonlinear Waveguides

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ABSTRACT

We present a protocol for generating continuous-variable multipartite entanglement based on spontaneous parametric down-conversion (SPDC) in a circular array of quadratic nonlinear waveguides (ANWs). The circular topology of the proposed system is very important and has not been studied before: it has two zero-supermodes (Fourier modes) that remain squeezed and phase-matched during propagation, generating two sets of entangled states. The two entanglement layers – large spatially entangled states of odd modes and even modes – behave like parallel, minimally cross-talking quantum channels. The produced states are entangled and do not become separable as the propagation distance (z) increases, demonstrating the robustness and scalability of the proposed protocol for large waveguide arrays.

In this work, we provide a rigorous theoretical framework, present comprehensive derivations of the propagation equations, and identify the regimes in which analytical solutions are possible. Physical ingredients, such as propagation eigenmodes and symmetry-based analytical solutions, enable the generation of two sets of large, distributable entangled states: one with odd modes and the other with even modes of the array. These two sets of entangled spatial modes could be useful for parallel quantum computing and crosstalk-resilient quantum communications. Three different pump phase profiles are used to produce distinct output quantum correlations: the flat pump and the alternative π/2-phase pump produce entanglement, whereas the alternative π-phase pump does not. Crucially, under suitable pumping, the proposed setup enables active on/off switching of entanglement, offering a functional entanglement switch tailored for quantum networking applications and double the number of entangled modes compared to planar ANWs.

Keywords: *Quantum optics, Quantum information, Nonlinear waveguides, Entanglement*

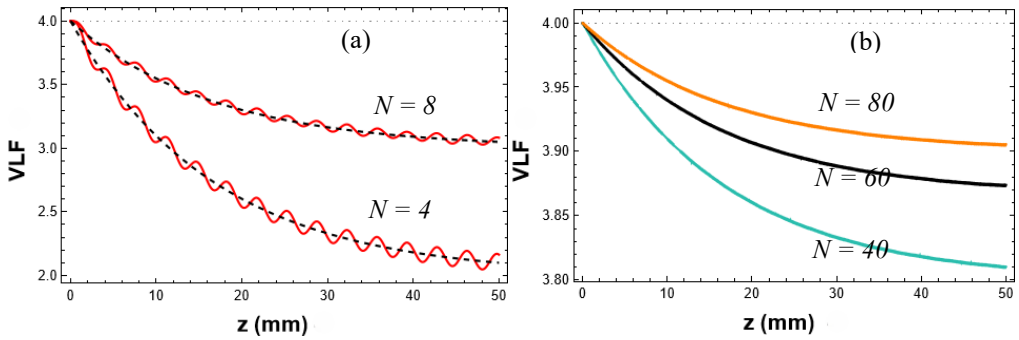


Fig. 1: Multipartite continuous-variable (CV) entangled state generation in the individual mode basis vs propagation distance (z). (a) van Loock-Furusawa (VLF) inequalities for circular ANWs, in the realistic coupling limit (Red) and in the infinite coupling limit (dashed Black). We have two sets of multipartite entangled modes with identical results, 1-3-5-7 and 2-4-6-8, in the waveguide array with N = 8. (b) VLF

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LSTM-Forecast-Aided Predictive Actor-Critic Parameter Tuning (P-APT) for UAV Relay-Assisted FSO Links under an Extended Composite-Impairment Channel Model

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ABSTRACT

Atmospheric attenuation, turbulence, aiming error, angle-of-arrival (AoA) fluctuations, and positional jitter of the relay platform affect relay-assisted free-space optical (FSO) communications carried unmanned aerial vehicles (UAVs). The authors' previous work tuned beam width, field-of-view (FoV), relay placement using population-based Integrated Alternating Weighted-Mean-of-Vectors optimizer (IA-WMoV) and single-actor reinforcement-learning controller (DRL-APT). Both methods treat UAV jitter static nominal parameter and reconfigure reactively. Paper presents P-APT, predictive actor-critic parameter-tuning framework that: (i) uses compact LSTM forecast UAV's one-step-ahead positional jitter so that reconfiguration occur before rather than after jitter spike; (ii) adds dynamic per-hop transmit-power allocation to the tunable parameter set along with beam width, FoV, relay spacing; (iii) pairs this controller with upgraded transceiver inside extended composite channel model. P-APT is compared against re-optimized IA-WMoV baseline and re-trained DRL-APT-style actor in sunny, thin-fog, and moderate-fog regimes under single, re-implemented channel model and similar Monte-Carlo evaluation. In comparison to IA-WMoV, P-APT reduces average bit-error rate (BER) by 7.9× and outage probability by roughly 31× under sunny skies, by 4.7× and 6.8× under thin fog, stays within same order magnitude in dense (moderate) fog, regime is attenuation-limited regardless parameter tuning, at reference operating point of 4 dBm. Adaptability is not only reactive but also proactive.

Keywords: *Free-Space Optical (FSO) Communication, UAV Relays, Long Short-Term Memory (LSTM), Atmospheric Turbulence, Pointing Error, Angle of Arrival (AoA).*

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Flexible and Conformal Antennas for Multi-Domain Wireless Applications: A Review

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ABSTRACT

Flexible and conformal antennas are thin, bendable radiating elements designed to conform to curved, moving, or body-worn surfaces rather than remaining flat and rigid. In today's wireless systems where devices continue to become smaller, wearable, and embedded into everyday objects, such antennas are gaining major importance for maintaining reliable connectivity without adding bulk or discomfort. Bending and stretching, however, alter the antenna's geometry, shifting its operating frequency, disrupting impedance matching, reducing radiation efficiency, and increasing unwanted interaction with nearby skin or surfaces. Environmental factors such as moisture and high temperatures further degrade performance.

This review consolidates recent developments in flexible substrate materials such as polyimide, Polydimethylsiloxane (PDMS), Polytetrafluoroethylene (PTFE), Polyethylene Terephthalate (PET), textile fabrics, and liquid crystal polymer. It also covers printed and additive manufacturing techniques and design approaches such as slot loading and metasurface integration that help address these challenges. It further surveys real-world applications in healthcare monitoring, wearable technology, biomedical devices, Internet of Things (IoT), Radio Frequency Identification (RFID), automotive radar, and drone-based systems. It highlights future directions for integrating these antennas with emerging technologies such as millimeter-wave networks, energy-harvesting circuits, and intelligent reconfigurable systems for next-generation wireless devices.

Keywords: *Flexible antenna, Wearable technology, Additive manufacturing, RFID, IoT, Millimeter-wave*.

ICAPST-2026-ESHT-124613

SYNTHESIS AND ELECTROCHEMICAL INVESTIGATION OF A BI-METALLIC FERRITE FOR AQUEOUS SODIUM- ION COIN CELL APPLICATION

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ABSTRACT

The demand for aqueous sodium-ion batteries (SIB's) has been gradually recognized as viable solutions for large scale energy storage systems because of their inherent safety, environmentally friendly as well as low cost. The study introduces bi-metallic spinel ferrite electrode material Na-$Mn_{0.5}Ni_{0.5}Fe_2O_4$ (Na-MNF) for aqueous sodium-ion battery application. The electrode material was synthesized via sol-gel conventional method to achieve compositional homogeneity and well-defined spinel structure, followed by fabrication of electrode pellets suitable for coin cell assembly. A comprehensive physical and electrochemical characterizations render the suitable properties for electrochemical applications. The integration of material design and device fabrication methodologies demonstrates the practical applicability of bi-metallic ferrite for safe and sustainable aqueous sodium-ion coin cells. Thus, this study finds to demonstrate a strong foundation for further optimization through compositional tuning, and long-term cycling studies, thereby contributing meaningfully to the development of next-generation aqueous energy storage technologies.

Keywords: *Aqueous sodium-ion battery, bi-metallic spinel ferrites, coin cell assembly, rechargeable energy storage system.*

ICAPST-2026-ESHT-223285

Two-Dimensional Material-Enabled Interface Engineering of WO_3/MXene Heterostructures for Efficient Solar-to-Hydrogen Conversion

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ABSTRACT

Efficient and stable photoelectrodes are crucial for sustainable solar-driven hydrogen generation, and interface engineering using two-dimensional materials provides an efficient method to improve charge transfer and mitigate recombination. This research entailed the fabrication of WO_3/MXene on FTO substrates as photoelectrode materials to investigate the photoelectrochemical (PEC) water splitting reaction. MXene was drop-cast onto a thin coating of WO_3 because of its superior conductivity and better charge transfer resulting from its active surface chemistry. The WO_3/MXene photoanode exhibits a markedly elevated photocurrent density (2.4 mA/cm^2 at 1.4 V against Ag/AgCl) relative to the unadulterated WO_3 thin film, with improved stability attributed to the incorporation of MXene, which promotes greater charge separation and higher interfacial conductivity. Electrochemical impedance spectroscopy (EIS) assessments confirm the reduced charge transfer resistance and enhanced interfacial kinetics for the WO_3/MXene sample. These results may facilitate the fabrication of a stable photoanode for large water-splitting applications.

Keywords: *MXene, 2D materials, WO_3 nanostructures, photoelectrochemical water splitting, and hydrogen generation.*

ICAPST-2026-ESHT-234398

Electrolyte-Dependent Electrochemical Performance of Banana Peel-Derived Biochar Electrodes for Integrated Chemical Waste Filtration and Multi-Ion Energy Storage

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ABSTRACT

The shift toward sustainable, low-cost energy storage has intensified interest in biomass-derived carbons as alternatives to graphite and metal-oxide electrodes. This study reports a dual-function strategy in which banana peel biochar waste is deployed simultaneously as a chemical wastewater filtration medium and as an active electrode material for multi-ion energy storage, showing a coupling of pollutant remediation with electrochemical value recovery within a circular-economy framework. Biochar electrodes were evaluated by cyclic voltammetry and Electrochemical Impedance spectroscopy (-1.0 to +1.0 V, 0.05 mV/s) in five different 2M sulphate electrolytes Na_2SO_4, Li_2SO_4, $ZnSO_4$, $MnSO_4$, and $MgSO_4$ before and after biochar filtration which shows probing charge-transfer behaviour. All electrolytes showed distorted quasi-rectangular voltammograms indicating mixed double-layer and pseudocapacitive storage, confirming active ion adsorption by the biochar's porous, oxygen-functionalized surface. Thus, the study shows banana peel derived biochar as low-cost, multifunctional material for pollutant-capture and multi-ion energy storage.

Keywords: *Banana peel biochar, Electrolyte-dependent electrochemistry, Multi-ion batteries, Chemical waste filtration, Cyclic voltammetry, Circular economy.*

ICAPST-2026-ESHT-308347

To Enhance Electrochemical Parameters of Supercapacitor Using Transition Metal Oxide (TMO) Based Electrode Material

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ABSTRACT

Pristine and Ni-doped δ-MnO_2 nanostructures were synthesized and investigated as electrode materials for supercapacitor applications. The structural, morphological, elemental, and thermal properties were studied using XRD, SEM, EDX, and TGA. XRD confirmed the formation of the δ-MnO_2 phase with structural modifications due to Ni incorporation. SEM revealed a nanoflake-like morphology, while EDX confirmed the presence and distribution of the constituent elements. TGA analysis demonstrated the thermal stability of the synthesized materials. The electrochemical performance was evaluated using cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS), revealing the capacitive behavior and charge-transfer characteristics of the electrodes. The results indicate that Ni doping effectively modifies the properties of δ-MnO_2, highlighting its potential as a promising electrode material for supercapacitor applications.

Keywords: *δ-MnO_2, Nickel doping, Nanostructures, Supercapacitors, XRD, SEM, EDX, TGA, Cyclic Voltammetry, Electrochemical Impedance Spectroscopy.*

ICAPST-2026-ESHT-347042

Structural and Morphological properties of Zr-MOF/Polystyrene Films

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ABSTRACT

In this study, we prepared PS nanocomposites containing 1–4 wt% Zr-MOF using a simple solution-casting method. After fabrication, we examined the samples with XRD, FTIR, and SEM measurements. The XRD results show that adding Zr-MOF increases the crystallinity of PS, while FTIR was used for identification of chemical bonding in Zr-MOF/PS polymer nanocomposites. The SEM images clearly demonstrate that the MOF particles are well dispersed throughout the polymer. The systematic investigation of the structural and morphological evolution provides valuable insights into the compatibility and microstructural characteristics of Zr-MOF/PS nanocomposites, highlighting their potential as advanced polymer composite materials for functional applications. These findings and their significance will be explained further during the conference presentation.

Keywords: *Polymer nanocomposite, Dispersion, Zr-MOF, PS.*

ICAPST-2026-ESHT-402757

Exploring the Energy Storage Capabilities of Biodegradable Kitchen Waste

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ABSTRACT

Biodegradable kitchen waste is one of major raw source for valuable transformed products as fertilizer, skincare, energy storage materials. It is abundant, ease to available, nature friendly, rich source of carbon, and low cost. It offers the potential to diminish of air and water bodies pollutions and hence improve the health of the environment. The major sources under consideration are onion waste, potato waste, cucumber waste, garlic waste, and green coriander waste.

The innovative work will focus on exploring the energy storage capabilities of biodegradable kitchen waste. The mixed household kitchen waste collected from house itself and washed 3-4 times with demineralized water to remover dirt and put for dry under ventilated and environmental condition for 2 days. The dried sample undergone for TGA characterization and analyzed. The pyrolysis and annealing of sample has carried out at optimized temperature and duration. The obtained sample will be characterized for elemental analysis and surface morphology.

The cyclic voltammetry will be performed to exploring the energy storage capabilities in symmetric electrode configuration with 1M KOH electrolyte. The impedance spectroscopy (at 5 mV ac signal) of fabricated cathode will also deliver the insights and potential capability as use in energy storage devices.

Keywords: *Pyrolysis, TGA, Elemental analysis*, *Cyclic voltammetry, Specific capacity.*

ICAPST-2026-ESHT-614715

Electrochemical Studies of BFO/Graphene Composite Hybrid Supercapacitors Employing an Ionic-Liquid Gel Polymer Electrolyte

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ABSTRACT

Supercapacitors are promising energy-storage devices known for high power density, rapid charge–discharge capability, and excellent cycling stability. Hybrid supercapacitors combine electric double-layer and faradaic charge-storage mechanisms, offering improved energy density while retaining good power performance. Recently, Bismuth ferrite ($BiFeO_3$) has emerged as an attractive electrode material for next-generation supercapacitors due to its unique multiferroic nature, rich redox activity, and environmentally friendly composition.

In this work, an ionic liquid entrapped gel polymer electrolyte (ILGPE) based on PVdF-HFP and EMImTFSI was prepared using the solution-casting technique and integrated with Bismuth Ferrite (BFO) and graphene composite (BFO/Gr) electrodes for supercapacitor applications. The polymer membrane exhibited high ionic conductivity (~1.12×10^{-3} S cm^{-1}) and good electrochemical stability window (~2.6 V). The BFO was synthesized via the sol–gel method, while its composite was obtained through an ultrasonication-assisted solution method. Two symmetric supercapacitor cells were fabricated utilizing BFO and BFO/Gr as the active electrodes, paired with the prepared ionic liquid-entrapped gel polymer electrolyte (GPE) serving simultaneously as the separator and ion conductor. The assembled supercapacitor Cells will be comprehensively evaluated via electrochemical impedance spectroscopy (EIS), cyclic voltammetry (CV), and galvanostatic charge–discharge (GCD) techniques. The BFO/Gr-based cell demonstrated superior capacitance, improved ion diffusion, and enhanced electrochemical performance.

Keywords: *Bismuth ferrite, Graphene, polymeric electrolyte, Hybrid supercapacitor, Electrochemical studies.*

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Investigation of Heat Storage Materials Using an Electric Backup Solar Cooker

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ABSTRACT

The integration of heat storage materials (HSMs) in solar cookers helps to store heat during sunny periods and serves as a heat back-up during low solar radiation due to intermediate clouds. In this paper, a method is developed to evaluate the performance of different HSMs by employing an electric back-up solar cooker. Two sensible and four phase change materials were selected based on their physical and chemical properties. The performance parameters were proposed for evaluating the behaviour of the selected HSMs in preheating, sensible heating and heat discharging modes. For selected HSMs, a variation of charging rate between 0.507 and 2.085 °C/min was observed during preheating mode. The maximum thermal efficiency determined to be 98% for glycerine, in the sensible heating mode. In the heat discharging mode, the minimum discharging rate was found to be 0.241 °C/min for glycerine. Overall, this work demonstrates the viability of HSMs in solar cookers to enhance cooking efficiency, contributing to the development of off-grid and sustainable cooking technologies. It also advocates glycerine as an excellent HSM for solar cooking applications.

Keywords: *Electric back-up solar cooker, Heat storage materials, Phase change materials, Glycerine.*

ICAPST-2026-ESHT-669126

Crystallization Kinetics and Relaxation Behavior of Bismuth-Based Glasses

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ABSTRACT

The thermal and electrical properties of the investigated glass system were examined to understand the impact of substituting CdO with Bi_2O_3. Non-isothermal DSC techniques were used to evaluate crystallization kinetics and thermal behavior. To assess the glasses' thermal stability, important thermal parameters such as glass transition temperature (T_g), crystallization peak temperature (T_c), and melting temperature (T_m) were extracted from DSC curves. Additionally, the Kissinger and Matusita–Ozawa methods were used to determine the activation energies for the glass transition and crystallization processes. The BBCL-2 glass composition shows higher values for the computed thermal stability parameters, especially Hurby's parameter, suggesting that it has better thermal stability than other samples. Impedance spectroscopy has been used to investigate the electrical characteristics of all manufactured glass samples across a broad range of frequencies and temperatures. An innovative method for understanding phenomena like electrode polarization and bulk conductivity qualities in terms of conductivity relaxation durations is the electric modulus analysis (□). The identical ionic transport mechanisms are shown by the identical activation energies for conduction and relaxation, suggesting these glasses are useful for ion-conducting applications.

Keywords: *Impedance Spectroscopy, Activation energies, Relaxation behavior, Hurby parameter.*

ICAPST-2026-ESHT-786128

Effect on Structural, Morphological, and Electrochemical Properties of Tin Doping on Cobalt Oxide Synthesized by Solvo-Combustion Method for Supercapacitor Applications

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ABSTRACT

Supercapacitors have attracted considerable attention as energy storage devices for renewable energy systems. In this work, the solvo-combustion method was used to synthesize pure cobalt oxide and Sn-doped Co_3O_4 nanoparticles, and heat treatment was used to investigate the effect on the Sn-doped Co_3O_4 material. The impact of tin incorporation on their structural, morphological, and electrochemical properties was systematically examined. XRD analysis confirmed the formation of a single-phase spinel Co_3O_4 retained in both samples; however, a slight shift in diffraction peaks was observed after tin doping, indicating successful lattice modification without secondary phase formation. Furthermore, FTIR, FE-SEM, Raman, BET, and XPS analyses verified the chemical bonding, surface morphology, crystal structure, surface area, and mixed Co^{+2}/Co^{+3} oxidation states. The doped samples exhibited modified crystallite size and lattice distortion, providing additional electrochemically active sites and facilitating charge transport. Electrochemical behavior was analyzed using CV, GCD, and EIS, which demonstrated the improved capacitive behavior, attributed to the synergistic effect of tin incorporation, increased surface activity, and enhanced ion/cation diffusion kinetics. Furthermore, the superior electrochemical performance of the Sn-doped Co_3O_4 electrode is optimized compared with pure Co_3O_4, which highlights the effectiveness of tin doping in improving redox activity and energy storage capability.

Keywords*: Solvo-Combustion, Tin-doped cobalt oxide, Morphology, Supercapacitor.*

ICAPST-2026-ESHT-832367

Experimental Study of Building Integrated Solar Cooker with Storage

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ABSTRACT

Solar thermal energy storage is an effective approach for making solar cooking more reliable and extending the use of solar energy beyond periods of strong sunlight. In this study, the thermal performance of the Building Integrated Solar Cooker (BISC) was evaluated and compared with a Commercial Box Solar Cooker (CBSC) under different operating conditions. In the stagnation test conducted without load and without a reflector, the absorber plate temperature of the BISC reached 122.8 ℃, compared with 108.1 ℃ for the CBSC, with corresponding F_1 values of 0.116 and 0.094 ℃m^2/W. With a reflector, the stagnation temperature increased to 149.8 ℃ for the BISC and 130.8 ℃ for the CBSC, respectively. The BISC was further tested with a sunflower oil-based thermal storage system using two fin configurations, namely rectangular fins and ring fins. Single-cycle tests with rectangular fins showed water temperatures up to 87.3 ℃, while tests with ring fins achieved up to 90.4 ℃. The ring-fin configuration was also tested for dual-cycle operation, where water temperatures of about 90 ℃ and 84 ℃ were achieved during the first and second cycles, respectively. The BISC offers good thermal performance and effective heat storage for repeated solar cooking.

Keywords: *Solar Cooker, Stagnation Test, Heat Storage, Thermal Performance, Sunflower Oil.*

ICAPST-2026-NPHP-152814

CP asymmetries in semileptonic decays $B \rightarrow K^* \mu^+ \mu^-$ and $B_s \rightarrow K^* \mu^+ \mu^-$

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ABSTRACT

To explore correlated CP-violating effects in rare semileptonic B decays by identifying interference-based observables sensitive to new complex phases that simultaneously affect the $b \rightarrow s\mu^+\mu^-$ and $b \rightarrow d\mu^+\mu^-$ transitions. While the new physics in $b \rightarrow s\mu\mu$ is extensively studied due to the flavour anomalies in this sector, the new physics $b \rightarrow d\mu\mu$ is less explored but it is equally important to test the lepton flavour universality. A correlated study of both sectors offers a novel handle on potential new sources of CP violation that cannot be explained by CKM phases alone. The deviation in $b \rightarrow s$ sector suggests a flavour changing new physics.

Keywords: *CP violation, Semileptonic B decays, Flavour anomalies, Lepton flavor universality, CKM phases, Flavour changing currents.*

ICAPST-2026-NPHP-167679

Exploring New Physics Effects in Λb → Λcℓν and Λb → Λνν̄ Decays within the Standard Model Effective Field Theory

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ABSTRACT

Semileptonic and rare baryonic decays provide complementary probes of physics beyond the Standard Model (SM). We investigate Λb → Λcℓν and Λb → Λνν̄ within the Standard Model Effective Field Theory (SMEFT), extending SMEFT studies of mesonic b-hadron decays to a baryonic system with different hadronic dynamics. We consider dimension-six operators contributing to charged-current and flavour-changing neutral-current transitions and evolve their Wilson coefficients to the low-energy scale. Using current baryonic form-factor inputs, we study branching fractions, differential rates, lepton-flavour-universality ratios, angular observables and polarization fractions. Preliminary sensitivity studies indicate that charged-current observables in Λb → Λcℓν can distinguish different vector and tensor operator contributions, while Λb → Λνν̄ provides complementary sensitivity to left- and right-handed neutral-current interactions. Correlations between these channels can therefore help separate SMEFT scenarios that produce similar effects in individual observables. The analysis aims to determine the allowed Wilson-coefficient regions and identify the most sensitive observables for future measurements at LHCb and other flavour experiments. This study provides a model-independent framework for testing new physics through baryonic beauty decays.

Keywords: *SMEFT, Baryonic Decays, Heavy-Flavor Physics, Wilson Coefficients, Lepton Flavor Universality, New Physics.*

ICAPST-2026-NPHP-205601

Mass-Radius Relation of White Dwarfs Using Chandrasekhar Theory

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ABSTRACT

White dwarfs are compact stellar remnants supported against gravitational collapse by electron degeneracy pressure. This work investigates their mass–radius relation using Chandrasekhar's theory. The equation of state of a degenerate electron gas is derived in the non-relativistic and ultra-relativistic limits and combined with the equations of hydrostatic equilibrium to obtain the Lane–Emden equation. The stellar structure equations are solved numerically using Python for different central densities. The resulting density, pressure, mass, and radius profiles are used to study the dependence of radius on mass and the transition to relativistic degeneracy. The study aims to demonstrate the characteristic decrease of white-dwarf radius with increasing mass and the emergence of the Chandrasekhar limiting mass of approximately 1.4 $M_{\odot}$.

Keywords: *White Dwarf, Chandrasekhar limit, Hydrostatic equilibrium, electron degeneracy pressure*

ICAPST-2026-NPHP-211250

Exploring Non-Standard Interactions in Neutrino Oscillations

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ABSTRACT

Neutrino oscillations provide direct evidence for physics beyond the Standard Model through the observation of non-zero neutrino masses and mixing. In this work, we explore the possible effects of Non-Standard Interactions (NSI) on neutrino oscillations in matter. We begin with the two-flavour neutrino oscillation framework and introduce the standard matter effect through the effective Hamiltonian. The Hamiltonian is then extended to include an additional NSI contribution, characterized by effective interaction parameters. The neutrino oscillation probabilities are evaluated numerically for different neutrino energies, propagation distances, and representative values of the NSI parameters using Python. A comparison between standard matter effects and the corresponding NSI scenarios is presented to illustrate how these interactions modify the oscillation probability. This study provides a simple numerical framework for understanding the role of NSI in neutrino propagation and serves as an introduction to exploring possible new-physics effects in current and future neutrino experiments.

Keywords: *Neutrino Oscillations, Non-Standard Interactions, Matter Effects, MSW Effect, Beyond the Standard Model, Neutrino Phenomenology.*

ICAPST-2026-NPHP-217509

Electron-Impact Inelastic Cross Sections for $C_3H_8O_2$ Isomers

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ABSTRACT

Electron-impact inelastic, ionization, and residual excitation cross sections are presented for eleven structural isomers of $C_3H_8O_2$ using the screening-corrected group additivity rule (GAR-SCAR) coupled with the spherical complex optical potential (SCOP) and complex scattering potential–ionization contribution (CSP-iC) formalisms. Target geometries and molecular descriptors were obtained at the $\omega B97X-D3$ & $aug-cc-pVTZ$ level. The calculations cover 11–5000 eV and examine the influence of ionization energy, polarizability, molecular topology, and inter-group screening. The Q_{inel} peak occurs at 53-58 eV with values of 18.124–19.845 Å^2, while the Q_{ion} peak occurs at 71–75 eV and range from 13.128–14.445 Å^2. The summed excitation contribution peaks earlier, at 35–39 eV, with values of 6.238–6.780 Å^2. Ethylmethylperoxide exhibits the largest Q_{inel} and Q_{ion}, whereas 1-methoxyethanol gives the smallest values. The results demonstrate clear isomeric effects arising from functional-group arrangement, ionization threshold, polarizability, and inter-group screening, and provide electron-collision data relevant to plasma, atmospheric, and astrochemical modelling.

Keywords: *Electron impact ionization, $C_3H_8O_2$ Isomers, GAR-SCAR, CSP-iC Method, Total Ionization Cross Section*, *Total Inelastic Cross Section & Summed Total Excitation Cross Section.*

ICAPST-2026-NPHP-239179

Neutron shielding investigation of polyethylene based composites with incorporation of Boron Carbide using Monte Carlo Simulation

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ABSTRACT

The harmful, toxic, and hazardous radiation emitted during nuclear operations in war, medical diagnosis, and the agriculture sector poses significant risks, making its prevention necessary to protect surrounding entities. Diagnosis, agriculture sector, nuclear power stations, and its prevention are necessary to protect surrounding entity. The 5 %, 10 %, 20 %, and 30 % B_4C-based borated polyethylene samples were examined under a 5 Ci Am-Be monodirectional beam source used to minimize edge effects. In a previously published article, a collimated beam through using a paraffin collimator from an isotropic point source employed on samples. Findings so that macroscopic neutron removal cross section (Σ_R) increasing from PE to 80PE+20B_4C after it decreases. The values 0.177499 cm^{-1}, 0.177793 cm^{-1}, 0.184385 cm^{-1}, 0.184641 cm^{-1}, and 0.182073 cm^{-1} of Σ_R found corresponding to PE, 95PE+5B_4C, 90PE+10B_4C, 80PE+20B_4C, 70PE+30B_4C with uncertainty order of E−05. These results follow a published trend that was replaced by B_4C doping reduced the macroscopic neutron removal cross section. This study shows that two Different irradiation conditions require that the angular and energy distribution of neutrons behave differently during interaction. The angular and energy distribution of neutrons must behave differently during interaction.

Keywords: *PE, B_4C, Neutron dose, PHITS*

ICAPST-2026-NPHP-323223

A systematic review of study of Agegraphic dark energy model in F(Q) v/s F(R,T) gravity

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ABSTRACT

Modified gravity theories based on non- metric scalars and curvature matter coupling framework intervening with Agegraphic dark energy model results in various additions to geometric deductions of the general theory of relativity that can modify the cosmological dynamics without the requirement of cosmological constant. This systematic review presents the comparative analysis of theoretical formulation, cosmological evolution, stability and observational viability of Agegraphic dark energy in F(Q) and F(R,T) gravity. Study starts with geometric fundamentals and field equation of both modified gravity frameworks and then reviews the newly formed Agegraphic dark energy in each theory. Then examining the resulting model using the evolution of the Hubble parameter, deceleration parameter, dark-energy density parameter and equation-of-state parameter. The study remains emphasised on stability of resulting cosmological solutions by perturbative and squared-speed-of-sound analyses, together with the behaviour of the null, weak, dominant, and strong energy conditions. The observation of the models is assessed through existing expansion-history constraints, including measurements and other relevant cosmological probes. Then, finding the chief theoretical and observational challenges, parameter degeneracies, and open problems in ADE-based modified gravity and highlight promising directions involving interacting dark energy, anisotropic cosmology, perturbation theory, and upcoming precision cosmological observations.

Keywords: *Agegraphic dark energy, F(Q) gravity, F(R,T) gravity.*

ICAPST-2026-NPHP-336717

Parametric Evaluation and Magneto-Stabilization of Thermal-Ponderomotive Filamentation in Moving Plasmas: A Fluid-Dynamical Study

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ABSTRACT

Laser-plasma interactions in high-energy-density physics and inertial confinement fusion are highly susceptible to thermal-ponderomotive filamentation instabilities, which severely degrade beam symmetry. This study presents a comprehensive fluid-dynamical evaluation of the simultaneous, competing effects of a transverse plasma flow velocity and an external axial magnetic field on filamentation dynamics. By linearizing the electron transport equations under a quasi-static framework, we analytically derive expressions for the spatial density perturbation magnitude $|n_1/n_0|$ and the spatial growth rate (Γ_{RCP}) of the Right-Circularly Polarized laser mode. Our findings establish a detailed pictorial curve demonstrating that $|n_1/n_0|$ exhibits a monotonic decay as the normalized magnetic field (ω_{ce}) scales from 0.1 to 0.8, confirming robust magneto-stabilization via an enhanced unified fluid rigidity index (D). Conversely, accelerating the normalized plasma flow (ω_{cf}) reduces D, inducing a super-exponential amplification of structural density fluctuations. Crucially, tracking (Γ_{RCP}) uncovers a striking, non-monotonic U-shaped dependency on ω_{ce}, identifying a distinct optimal mitigation window at $\omega_{ce} \approx 0.55$–0.60 where spatial growth reaches a global minimum. Past this threshold, cyclotron resonance driving ($|\omega_0 - \omega_{ce}| \to 0$) triggers explosive instability acceleration. Configuring the system near $\omega_{ce} \approx 0.60$ provides a resilient buffer that flattens the destabilizing curves under high dynamic flow conditions.

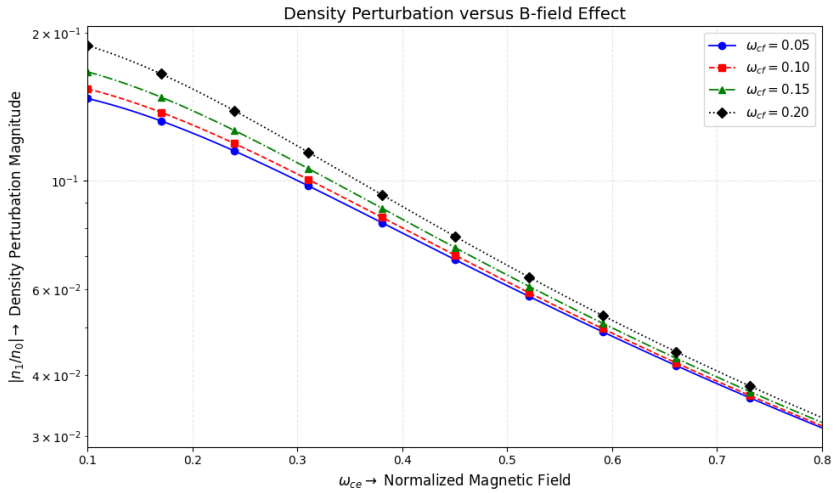


Figure 01: Monotonic decay of spatial density perturbation magnitude $|n_1/n_0|$ as a function of normalized magnetic field scaling from 0.1 to 0.8.

Keywords: *Laser-plasma interactions, Thermal-ponderomotive filamentation, Magneto-stabilization, Plasma flow, Electron cyclotron resonance, Fluid-dynamical modelling.*

ICAPST-2026-NPHP-338892

Dark and Bright envelope solitons in an unmagnetized dusty plasma having two-temperature Maxwellian electrons

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ABSTRACT

The nonlinear propagation of envelope solitary waves in a homogeneous, unmagnetized dusty plasma comprising warm positive ions, warm negatively charged dust grains, and two-temperature electrons is investigated theoretically. The electron populations are described by cold and hot Maxwellian distributions, while the finite temperatures of the ions and dust grains are taken into account. Using the Krylov-Bogoliubov-Mitropolsky (KBM) perturbation technique, the governing fluid equations are reduced to a nonlinear Schrödinger (NLS) equation that describes the evolution of slowly varying wave envelopes. The corresponding dispersion and nonlinear coefficients are derived analytically in terms of the relevant plasma parameters. The existence and characteristics of bright and dark envelope solitons are examined by analyzing the signs and magnitudes of these coefficients. Numerical investigations are performed to determine the parameter regimes in which bright or dark envelope solitons can exist. In particular, the effects of dust concentration and ion temperature on the formation and properties of the envelope structures are examined. The results show that variations in dust concentration and ion temperature significantly modify the plasma's dispersive and nonlinear properties and, consequently, influence the existence of bright and dark envelope solitons. These findings may be useful for understanding nonlinear envelope excitations in astrophysical and space dusty plasmas.

Keywords: *Dusty plasma, Krylov-Bogoliubov-Mitropolsky (KBM) perturbation technique, Dark and Bright Envelope solitons, Schrödinger Equation.*

ICAPST-2026-NPHP-378354

Magnetic Monopoles, Glueballs and Deconfinement in Finite-Temperature SU(3) QCD

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ABSTRACT

We investigate the confinement–deconfinement phase transition in pure (SU(3)) Quantum Chromodynamics (QCD) at finite temperature using the dual QCD framework. A gauge-invariant decomposition of the non-Abelian gauge field is employed to identify magnetic monopole degrees of freedom, whose condensation provides a dynamical mechanism for color confinement through the dual Meissner effect. The finite-temperature behavior is studied by constructing the one-loop effective potential within the imaginary-time formalism. The magnetic monopole condensate evolves with temperature and serves as an effective order parameter for the confinement–deconfinement transition. As the temperature increases toward the critical region, the condensate decreases and eventually vanishes, accompanied by the disappearance of the dual Meissner effect and the dissolution of chromoelectric flux tubes. We further analyze the temperature dependence of gauge-invariant vector and scalar magnetic glueball masses derived from the effective potential. Both masses decrease with increasing temperature and disappear near the critical point, indicating the melting of glueball excitations in the deconfined phase. Our numerical analysis indicates a first-order deconfinement transition, consistent with the expected behavior of pure (SU(3)) gauge theory. The results demonstrate the usefulness of dual QCD for describing non-perturbative confinement dynamics and finite-temperature strongly interacting matter.

Keywords: *Dual QCD, Non-Perturbative Dynamics, Confinement, Deconfinement Phase transition.*

ICAPST-2026-NPHP-393163

Quantum Simulation of an Anharmonic Oscillator Using Variational Quantum Eigensolver

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ABSTRACT

The anharmonic oscillator is an important quantum-mechanical system that helps us understand the effects of nonlinear interactions. In this work, we investigate a one-dimensional quartic anharmonic oscillator using both classical numerical methods and quantum computing techniques. The Hamiltonian is represented in a finite-dimensional basis, and its energy eigenvalues are calculated using exact diagonalization. For weak anharmonic coupling, the results are compared with first-order perturbation theory. The system is then simulated using the Variational Quantum Eigensolver (VQE), a hybrid quantum–classical algorithm used to estimate ground-state energies. The dependence of the energy spectrum on the anharmonic coupling and the accuracy of the variational method are studied. This work provides an introductory understanding of quantum simulation and demonstrates how quantum algorithms can be applied to nontrivial problems in quantum mechanics.

Keywords: *Anharmonic oscillator, Quantum simulation, Variational Quantum Eigensolver, Quantum computing, Perturbation theory.*

ICAPST-2026-NPHP-399646

Exploring the Magnetic Field and Radius of Influence Around Black Holes

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ABSTRACT

Understanding accreting black hole environments remains central to high-energy astrophysics, particularly regarding how central engines power relativistic jets and interact with surrounding gas. This study revisits the characteristic radius of influence R_p and its corresponding area of influence A to quantify the spatial extent and cross-sectional domain over which a black hole's magnetic and energetic output alters its medium.

Initial exploratory models relied on simplified phenomenological scaling combining dark matter density, magnetic field strength, and distance, but lacked rigorous physical justification and magnetohydrodynamic derivation. Addressing these limitations, this work establishes a revised, physically grounded framework by examining relativistic jet propagation and jet-medium interactions, including shocks, cocoon dynamics, and pressure balances.

We first identify the governing environmental parameters: ambient density, pressure gradients, jet luminosity, and black hole mass. From these foundations, we outline a systematic methodology to derive a dimensionally consistent scaling relation for R_p, and subsequently evaluate A. The resulting mathematical model will be tested through Python-based numerical implementations and compared against established theoretical literature, clarifying how black hole outflows shape galactic environments.

Keywords: *Black Holes, Magnetic Fields, High-Energy Astrophysics, Accretion Disks, Relativistic Jets*

ICAPST-2026-NPHP-422929

Fusion studies in $^{28}Si+^{128}Te$ reaction at energies around the Coulomb barrier

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ABSTRACT

Sub-barrier fusion provides a sensitive probe of quantum tunnelling and channel-coupling effects in heavy-ion reactions. Experimental studies have shown that sub-barrier fusion cross-sections exceed the predictions of the one-dimensional barrier penetration model (1D-BPM) due to couplings between the relative motion and intrinsic nuclear degrees of freedom. To investigate these coupling effects, we measured the fusion excitation function for the $^{28}Si + ^{128}Te$ system.

The experiment was carried out at Inter University Accelerator Centre, New Delhi, using the 15 UD Pelletron accelerator in the Heavy Ion Reaction Analyzer (HIRA). Isotopically enriched ^{128}Te targets of thicknesses ≈330 μg/cm^2 with carbon backing (≈30 μg/cm^2) were used in the experiment. The evaporation residues (ERs) were separated by HIRA according to their mass-to-charge (m/q) ratio and identified at the focal plane using a multiwire proportional counter through combined time-of-flight (ToF) and ΔE measurements. A well-separated ToF–ΔE spectra were obtained at all beam energies, and ER cross-sections were calculated, which exhibit sub-barrier fusion enhancement compared with the 1D-BPM predictions. As PACE4 calculations indicate a negligible fission contribution in the respective system, the ER cross-sections are taken as the fusion cross-sections. Further theoretical analysis is in progress.

Keywords: *Quantum tunnelling, Fusion excitation function, One-dimensional barrier penetration model, Sub-barrier fusion enhancement.*

ICAPST-2026-NPHP-440105

Joule-Thomson Expansion and Photon Sphere Lyapunov Instability of Charged AdS Black Holes in $f(R, T)$ Gravity with Nonlinear Electrodynamics

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ABSTRACT

We investigate the thermodynamic and dynamical properties of a charged AdS black hole (BH) in $f(R, T)$ gravity coupled to nonlinear electrodynamics (NLED), with particular emphasis on the instability of photon sphere orbits. The Joule-Thomson (JT) expansion analysis reveals that the inversion temperature and cooling-heating behaviour are strongly influenced by the BH charge, while NLED and modified gravity corrections introduce additional shifts to the inversion curves. The resulting inversion structure consists of a single branch, similar to that of Reissner-Nordström-AdS BHs. To explore the dynamical characteristics of the spacetime, we examine null geodesics and determine the properties of unstable circular photon orbits. Using the effective potential, we calculate the Lyapunov exponent associated with the photon sphere and analyse its dependence on the modification parameters. We find that BH charge plays the dominant role in controlling orbital instability, whereas the NLED and $f(R, T)$ corrections contribute comparatively weaker modifications. The behaviour of the Lyapunov exponent reflects the underlying thermodynamic structure, suggesting a close connection between photon sphere instability and BH thermal properties. Our results demonstrate that the Lyapunov exponent provides an effective probe of charged AdS BHs in modified gravity and offer insights into the relation between spacetime instability and black hole thermodynamics.

Keywords: *Black hole thermodynamics, Joule-Thomson effect, Geodesics, Lyapunov Exponent, Photon sphere.*

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Light Deflection and Greybody Bound Around a BTZ-ModMax Black Hole in Plasma Medium

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ABSTRACT

We study the deflection of light in a homogeneous plasma medium around a BTZ–ModMax black hole, focusing on the effects of the ModMax nonlinear electrodynamics parameter and the cosmological constant. Using the Gauss–Bonnet theorem applied to the corresponding optical geometry in plasma; we derive a modified expression for the deflection angle and examine how plasma dispersion alters the gravitational lensing behavior. The influence of the ModMax parameter in the presence of homogeneous plasma is compared with its vacuum counterpart, as well as with the charged and static BTZ black hole cases, revealing distinct signatures arising from nonlinear electrodynamics. This work highlights the combined impact of homogeneous plasma, spacetime curvature, and nonlinear field dynamics on light deflection in lower-dimensional black hole geometries. We further study the greybody factor and analyze how the presence of homogeneous plasma and the ModMax parameter modifies the energy emission spectrum of the black hole. Our results demonstrate that both plasma effects and nonlinear electrodynamics significantly influence the transmission probabilities and emission rates, providing deeper insight into wave propagation and observational signatures in lower-dimensional black hole geometries.

Keywords: Lensing, Plasma, Radiation, ModMax.

ICAPST-2026-NPHP-529965

Bright and Dark Envelope Solitons in an Electron-Beam Plasma with Two-Temperature Electrons

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ABSTRACT

The existence of envelope solitons in an unmagnetized four-component plasma consisting of positive ions, an electron beam, and two populations of hot and cold electrons is investigated. The cold electrons are assumed to obey the Maxwellian distribution, whereas the hot electrons are described by the non-thermal Cairns distribution, which is more appropriate for representing high-energy electron populations commonly observed in space plasmas. The nonlinear Schrödinger equation (NLSE) is derived using the Krylov-Bogoliubov-Mitropolsky (KBM) perturbation method to examine the modulation of ion-acoustic wave packets. It is shown that the plasma system supports both bright and dark envelope solitons. The dispersion and nonlinear coefficients of the NLSE are obtained explicitly in terms of the relevant plasma parameters. The parametric regimes corresponding to the existence of bright and dark envelope solitons are investigated numerically. The present results provide a deeper understanding of the formation and propagation of nonlinear envelope structures in both space and laboratory plasma environments.

Keywords: *Krylov-Bogoliubov-Mitropolsky (KBM) method, Envelope solitons, Electron beam plasma, Non-thermal electrons.*

ICAPST-2026-NPHP-608570

Atmospheric Propagation and Plasma Control of Asymmetric Airy-Bessel Vortex Beams

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ABSTRACT

This work evaluates the long-range atmospheric transmission of high-power, asymmetrically truncated Airy-Bessel vortex beams. High-power laser channels typically suffer from heavy energy attenuation caused by strong-field ionization and subsequent plasma formation in ambient air. To resolve this operational bottleneck, we numerically simulate the beam's spatial propagation across varying integer topological charges (m = 1 to m=4) under a fixed exponential asymmetry baseline ($\alpha = 0.1$). Our split-step numerical framework operates under intense input conditions ($P_{in}/P_{cr} = 50.0$) up to a normalized distance of Z = 5.0. The results reveal that increasing the topological charge effectively expands the inner dimensions of the hollow vortex core, redistributing peak power and suppressing localized photoionization tracks. Notably, transitioning from m = 1 to m=2 yields a dramatic multi-fold drop in localized electron density down to 3×10^{-4}. This optimization highlights m = 2 as the ideal design configuration for low-loss, focused atmospheric transmission.

Keywords: *Asymmetric Airy-Bessel vortex beams, Atmospheric laser propagation, Plasma control in air, Reducing laser energy loss, Optical vortex optimization.*

ICAPST-2026-NPHP-630394

Recent Advances in Jet Substructure-based studies at Collider Experiments

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ABSTRACT

Jets, collimated sprays of particles produced by high-energy quarks and gluons, are among the most powerful probes of Quantum Chromodynamics (QCD) at collider experiments. Precision measurements of jet observables provide stringent tests of the Standard Model, while modern jet-substructure techniques offer detailed insights into parton radiation, hadronization, and the internal dynamics of jets. This work presents studies addressing both experimental precision and the exploration of QCD using jet-substructure techniques. Jet calibration based on the single-particle response of the ATLAS calorimeters is discussed as a method to improve jet energy measurements and reduce associated experimental uncertainties. The potential of the Lund Jet Plane (LJP) representation for precision QCD studies at future high-energy colliders is also explored, with particular emphasis on jet-tagging techniques for the Future Circular Electron-Positron Collider (FCC-ee). These studies demonstrate the potential of modern jet-substructure methods to improve the precision of jet measurements and enhance the physics reach of both current and next-generation collider experiments.

Keywords: *Jet Physics, Jet Substructure, Quantum Chromodynamics (QCD), Future Circular Collider (FCC-ee)*

ICAPST-2026-NPHP-694059

Activity Prediction of Radioactive Source Thallium-204 using an Artificial Neural Network

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ABSTRACT

This study explores a novel approach to predict the activity of the Thallium-204 (Tl-204) source by training an artificial neural network (ANN) on traditional radiometric data. ANNs have shown success in radioactivity applications, particularly in identification and quantification of radionuclides and real-time environmental monitoring. We recorded the gross counts of a Tl-204 source and background periodically using the GM counter with a fixed source-to-detector geometry. The net source count data and absolute activity, obtained using the standard calibration procedure, is used to train the ANN model. The trained ANN successfully reproduced the overall exponential decay trend of Tl-204 source, demonstrating its ability to learn the underlying temporal behavior of radioactive decay from experimental data. The model achieved a root mean square error (RMSE) of 487.49 Bq, maximum absolute percentage error (MAPE) of 27.92%, and Pearson correlation coefficient of R = 0.61, indicating a moderate agreement between the predicted and experimentally measured activity values. These findings suggest that integrating ANNs with conventional GM counting data offers a promising approach for radioactive source activity prediction. However, further improvements in data preprocessing, noise reduction, expanded training datasets and model optimization are required for reliable use in radiation safety and instrument calibration.

Keywords: *Artificial Neural Network, Geiger-Muller Counter, Predictive Modeling, Radiometric Activity, Time-Series Forecasting.*

ICAPST-2026-NPHP-760922

Time as a Relative State Function: A Unified Framework from B-series, Thermodynamics and Relativity

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ABSTRACT

This paper introduces a novel framework for the study of temporal mechanics by conceptualizing time as a relative state function. This approach is different from traditional relational theories, which visualize time as a one-way flow or an absolute dimension. The framework integrates ideas from McTaggart's B-relations with concepts from thermodynamics, like state functions and the entropic arrow of time. It's also compatible with special relativity, as shown through a thought experiment involving two isolated relativistic boxes. Crucially, this framework does not claim to eliminate time as a concept. Instead, it redefines what temporal differences measure: not an independent flow, but differences in physical state along a sequence of events ordered by B-relations. A mathematical structure is proposed to formalize this idea, and the implications are far-reaching. The framework could change our understanding of quantum gravity, relational mechanics, and the arrow of time. By reconsidering time as a relative state function, one can uncover new insights into the nature of reality itself. The research outlines the foundational implications of this new framework and facilitates the understanding of time and its role in the universe.

Keywords: *Thermodynamics, Special relativity, Two-box thought experiment, state functions, Time, Entropy.*

ICAPST-2026-NPHP-820959

Systematic Study of Pre-scission Neutron Multiplicity for Near-Superheavy Nuclei

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ABSTRACT

Understanding the mechanisms that govern energy dissipation and timescales in heavy-ion-induced fission remains a central challenge in nuclear reaction dynamics. In the present work, a systematic study of pre-scission neutron multiplicity (ν_{pre}) has been carried out for a range of near-superheavy nuclei within a selected excitation-energy window. The dependence of ν_{pre} on key entrance-channel and compound-nucleus properties, including the fissility parameter (χ), the entrance-channel mass asymmetry normalized to the Businaro–Gallone point (α/α_{BG}), and the neutron-to-proton ratio (N/Z) of the compound nucleus, has been investigated.

The analysis reveals an overall increase of pre-scission neutron multiplicity with fissility, indicating enhanced neutron emission for heavier and more fissile systems. A pronounced dependence on α/α_{BG} is also observed, with larger pre-scission neutron multiplicities in near-symmetric entrance channels, suggesting longer interaction times prior to scission. In contrast, systems characterized by more asymmetric entrance channels exhibit relatively lower ν_{pre}, consistent with shorter fission timescales. A weaker dependence on the compound-nucleus N/Z ratio is observed, although neutron-rich systems tend to show slightly enhanced pre-scission neutron emission. These observations provide valuable insight into the mechanisms governing fission dynamics of near-superheavy nuclei, thereby aiding the understanding of superheavy nucleus formation.

Keywords: *Fusion-Fission, Neutron Multiplicity, Compound Nucleus, Nuclear Dissipation, Entrance-Channel Mass Asymmetry.*

ICAPST-2026-NPHP-848676

Probing Scalar-Mediated Self-Interacting Dark Matter through White Dwarf Capture and Thermal Evolution

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ABSTRACT

Self-interacting dark matter (SIDM) in compact stars provides a powerful astrophysical avenue for probing dark matter interactions beyond the reach of terrestrial experiments. We develop a scalar-mediated SIDM framework for white dwarfs by extending the previous dark matter capture formalism to include self-interaction-enhanced capture, accumulation, and the time evolution of the trapped dark matter population. Recent neutron star studies have shown that SIDM can enhance stellar heating by up to an order of magnitude. Our white dwarf framework extends this phenomenology to a different compact-star environment, where comparable signatures are expected but are modified by the distinct capture efficiency, stellar composition, and thermal evolution of white dwarfs. Our results show that scalar-mediated self-interactions can significantly increase dark matter accumulation, leading to potentially observable heating of old, cool white dwarfs. Our study demonstrates the potential of white dwarfs as complementary astrophysical probes of scalar-mediated SIDM and provides a framework for constraining dark sector interactions through future observations of old, cool white dwarfs.

Keywords: *Self-Interacting Dark Matter, White Dwarfs, Scalar Mediator, Dark Matter Capture, Stellar Heating, Dark Sector*

ICAPST-2026-NPHP-860297

Shadow and deflection angle of charged rotating black hole surrounded by perfect fluid dark matter

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ABSTRACT

An analysis of the shadow cast by a charged rotating black hole in the presence of perfect fluid dark matter was conducted. Through an investigation of the null geodesic equations, the shadow of the charged rotating black hole was derived to determine the effects of the perfect fluid dark matter parameter γ, the charge Q, and the rotation parameter a. The results indicate that both the size and the geometry of the black hole shadow are significantly influenced by these parameters, demonstrating that the presence of dark matter alters the surrounding spacetime. Furthermore, the influence of these parameters on the effective potential and the energy emission rate was examined via graphical representation, with all outcomes systematically compared to the non-rotating case within standard general relativity. Finally, the impact of perfect fluid dark matter on the gravitational deflection angle and the subsequent dimensions of Einstein rings was explored.

Keywords: *Black Hole, Dark Matter, Shadow, geodesic equation.*

ICAPST-2026-NPHP-900793

Investigating the Impact of White Dwarf Composition on Light-Mediator Dark Matter Capture

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ABSTRACT

White dwarfs provide a promising astrophysical environment for probing dark matter (DM) interactions due to their high density and strong gravitational fields. In this work, we investigate how the internal nuclear composition of white dwarfs affects the capture of DM particles interacting with nucleons through a light scalar mediator. Following the light-mediator framework, we study the capture rate for different representative compositions, including helium (He), carbon–oxygen (C/O), and oxygen–neon (O/Ne), while varying the DM mass and mediator mass. The momentum-dependent nature of the scattering process is taken into account to examine how the capture efficiency changes with the target nuclear species and their relative abundances. We further compare composition-dependent capture rates and identify regions of the DM parameter space where variations in white dwarf composition can significantly influence the capture efficiency. The study aims to assess the importance of realistic white dwarf composition in deriving astrophysical constraints on light-mediator dark matter and provides a basis for more detailed studies of dark matter accumulation and observable effects in compact stars.

Keywords: *Dark Matter, White Dwarfs, Light Mediator, Dark Matter Capture, Stellar Composition, Astroparticle Physics*

ICAPST-2026-NPHP-902252

Study of fission dynamics in ^{30}Si + ^{182,184,186}W reactions populating isotopes of Ra

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ABSTRACT

Though fission was discovered 80 years ago, many fundamental aspects of fission remain unanswered. Fission and fission-like processes significantly hinder the synthesis of heavy and super heavy elements. In many reactions, the onset of quasifission is inferred from the broadened mass width. Being a transition state nucleus, asymmetric fission is also expected in the mass distribution of Ra and Th nuclei, which could lead to a broadening in the experimental mass distributions. Hence, it is very important to study the mass distribution of transition nuclei at various excitation energies.

The experiment was performed using the 15 UD Pelletron accelerator + SCLinac facilities of IUAC, New Delhi. Measurements were performed over an excitation energy range of 46–90 MeV using pulsed ^{30}Si beams incident on ^{182,184,186}W targets of thicknesses 405, 450, and 331 μg/cm^2, respectively. The complementary fission fragments were detected using a pair of identical position-sensitive multiwire proportional counters (MWPCs). The mass angle distribution was obtained using the position and timing signals obtained from the MWPC detectors. The GEF, Scission Point Model, Saddle point model and DNS calculations were performed to get more insight into the reaction dynamics. Determined the probability of qusifision, it increases with decreasing neutron number.

Keywords: *Fission, Quasifission, Fission fragments, MWPC, Mass angle distribution*.

ICAPST-2026-NPHP-917785

Self- Focusing of a Hermite Cosh Gaussian Beam in Plasma with Ripple Density in Relativistic and Ponderomotive Regime

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ABSTRACT

In the present manuscript, we have discussed relativistic self-focusing of a Hermite Cosh Gaussian laser beam under ripple density for mode indices m = 0, 1, 2. Due to relativistic and pondermotive nonlinearity, the dielectric function of plasma is modified and cause periodic self-focusing/defocusing of Hermite cosh Gaussian beam. For the theoretical framework, we have use paraxial approximation and WKB approximation to solve the complex propagation envelope of the laser beam. To solve the nonlinear differential equation of the beam width parameter, the Runge-Kutta method is used. The propagation of beam width parameter with propagation distance is studied significantly. With that, variation of beam width parameter with decentred parameter b and for different wave numbers q, it is studied. In is seen that self-focusing is decrease with increase of laser intensity and ripple wave number.

Keywords: *Self-focusing, beam width, ripple density, Hermite cosh Gaussian.*

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Nonlinear Fluid Simulation of Jeans Instability in Non-Maxwellian Magnetized Dusty Plasmas

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ABSTRACT

The classical Jeans instability framework provides a foundation for structural collapse and star formation in interstellar environments. However, real cosmic plasma mediums are inherently magnetized and frequently collisionless, exhibiting significant departures from local thermodynamic equilibrium. While linear theories predict initial instability thresholds, they fail to track the long-term nonlinear runaway dynamics. We present a fluid simulation investigating the nonlinear evolution of the Jeans instability in a magnetized tri-component dusty plasma. Electrons and ions are governed by the κ-distribution, while the heavier dust grains are treated as a fluid coupled to a uniform ambient magnetic field (B_0). The numerical architecture utilizes a fourth-order finite difference method (FDM) for spatial gradients and a second-order leap-frog time-integration scheme. We systematically investigate the competing feedback loops between the self-gravitational attraction, non-thermal electrostatic screening, and magnetic pressure across a sweep of plasma beta (β) parameters and magnetic field orientations. Preliminary results indicate that while decreasing the spectral index κ accelerates structural localization, the presence of a perpendicular magnetic field introduces a critical magnetosonic pressure barrier that shifts the instability thresholds and lengthens the characteristic collapse timescale (τ_c). This fluid framework provides a more comprehensive, observationally aligned look at early-stage star-forming seed beds within diffuse interstellar clouds.

Keywords: *Jeans instability, Gravitational collapse, Fluid dynamics, Magnetized Dusty Plasma*

ICAPST-2026-NPHP-965468

Flat-Top Solitary Waves in Dense Cold Ion Plasma with Relativistic Electrons and Positrons

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ABSTACT

Large-amplitude ion-acoustic flat-top solitons are investigated in cold electron–positron–ion (EPI) plasma using the nonlinear fluid model and the Sagdeev pseudo-potential approach. The plasma is assumed to consist of cold inertial ions together with electrons and positrons that provide the restoring force. The conditions governing the existence of large-amplitude flat-top solitary structures are derived by analysing the nonlinear energy integral. Numerical investigations demonstrate that the amplitude, width, and flat-top profile of the ion-acoustic solitons are strongly influenced by the positron concentration, electron-to-ion density ratio, and Mach number. It is found that an increase in the Mach number enhances the soliton amplitude while promoting the formation of broader, flat-top structures. Furthermore, variations in the positron population significantly modify the nonlinear potential well, thereby affecting the stability and propagation characteristics of the solitary waves. The results indicate that flat-top ion-acoustic solitons exist over a finite range of plasma parameters and represent a transition from conventional bell-shaped solitons to plateau-like nonlinear structures. These findings are relevant to understanding nonlinear electrostatic wave propagation in laboratory plasmas and astrophysical environments, including pulsar magnetospheres, white dwarfs, and other electron–positron–ion plasma systems.

Keywords: *Solitons, Nonlinear fluid model, Nonlinear electrostatic wave propagation*

ICAPST-2026-NPHP-976086

Symmetry Principles in Quantum Mechanics and Their Physical Implications

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ABSTRACT

Symmetry is often seen as a mathematical pattern, but in quantum mechanics it is much deeper. It is a principle on which physical laws are built. This paper investigates the symmetry principles underlying quantum mechanics and explores why they play such a fundamental role in shaping the physical world. I begin by building the mathematical foundation using group theory, showing how symmetry transformations are represented by operators acting on quantum states in Hilbert space. From there, I examine Noether's theorem, which establishes that every continuous symmetry corresponds to a conserved quantity—translational symmetry gives momentum, rotational symmetry gives angular momentum, and time symmetry gives energy conservation. I then examine parity and time-reversal symmetries, and the striking physical fact that nature does not always respect them. The parity violation observed in Wu's 1956 beta decay experiment stands as direct physical proof that symmetry has real and measurable limits. Finally, I show how symmetry arguments alone predict selection rules in atomic spectra — determining which transitions in hydrogen are allowed and which are forbidden. Across all these themes, one conclusion becomes clear: symmetry is not just a description of nature. It is nature's foundation.

Keywords: *Symmetry, Group theory, Noether's theorem, Conservation laws, Parity violation, Selection rules*

ICAPST-2026-RSES-100930

DFT Study of Heteroleptic Bis-diimine Cu(I) Complexes as Sensitizers for High-Performance Dye-Sensitized Solar Cells: Effects of Anchoring and Ancillary Ligand Modification

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ABSTRACT

Rationally designed Cu(I)-based sensitizers have emerged as promising, cost-effective, and earth-abundant alternatives for efficient dye-sensitized solar cells (DSSCs). A set of four heteroleptic bis-diimine Cu based dye complexes has been theoretically investigated by DFT calculations. In these dye complexes two different anchoring ligands 6,6'-dimethyl-2,2'-bipyridine-4,4'-dicyanoacrylic acid and 6,6'-dimethyl-2,2'-bipyridine-4,4'-dicarboxylic acid with two different ancillary ligands i.e. methyl functionalized 2,9-dimethyl-1,10-phenanthroline and dithiole functionalized 2,9-dimethyl-1,10-phenanthroline (dmp) has designed to study the improvement in photovoltaic efficiency. We performed PDOS calculations, natural transition orbital (NTO) analysis and TDDFT calculations to study their structural properties, electronic properties, optoelectronic properties, UV-visible absorption spectrum and charge transfer direction. Light-harvesting efficiencies (LHE) were observed in the order Dye1 (0.187) < Dye2 (0.213) < Dye3 (0.329) < Dye4 (0.342). Natural transition orbital (NTO) analysis demonstrated that lower energy excitations support favourable charge transfer mechanisms (MLCT and LLCT) and allow efficient electron injection. Heteroleptic bis-diimine Cu based dyes are efficient sensitizer, especially Dye4, those containing heteroatomic group like dithiole functionalized ancillary ligand and cyanoacrylic acid group as anchoring ligand, shows the best light-harvesting efficiency (LHE), good optoelectronic property, stronger absorption features, reduction in the HOMO-LUMO energy gap and efficient electron transfer compared with the other studied dyes.

Keywords: *Diamine Cu(I) complexes, NTO analysis, PDOS calculation, DSSCs, DFT, TD-DFT*

ICAPST-2026-RSES-289696

Influence of Annealing Environment on the Structural and Optical Properties of Sol-Gel Derived CZTS Thin Films

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ABSTRACT

Cu_2ZnSnS_4 (CZTS) is a promising quaternary semiconductor material for thin-film photovoltaic applications due to its suitable optical band gap and earth-abundant constituent elements. In the present study, CZTS thin films were prepared by a sol-gel spin-coating technique using chloride-based precursor solutions. The films were deposited at a spin speed of 3000 rpm and subsequently annealed at 450 °C for 30 minutes under different thermal processing environments, including nitrogen, hydrogen sulfide, and sulfurization conditions. The influence of these annealing environments on the structural and optical properties of the resulting films was investigated. Structural characterization was performed using X-ray diffraction (XRD) to examine phase formation and crystallinity. The XRD pattern exhibited a prominent (112) diffraction peak at $2\theta \approx 28.52°$, characteristic of the kesterite CZTS structure. Optical properties were investigated using UV–Vis spectroscopy, and the optical band gap was estimated from the Tauc relation to be approximately 1.55 eV. The comparison provides insight into the role of annealing environment in controlling the structural and optical properties of sol-gel-derived CZTS thin films and helps in optimizing the thermal processing conditions for potential photovoltaic and optoelectronic applications.

Keywords: *Cu_2ZnSnS_4, Sol-gel method, Thin films, Annealing environment, Optical properties*

ICAPST-2026-RSES-302044

Morphological and Elemental Characterization of Dust Deposited on Photovoltaic Modules Using SEM–EDS for Understanding Soiling-Induced Performance Degradation

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ABSTRACT

Dust deposition on photovoltaic (PV) modules is responsible for the reduction in optical transmittance and power outputs from solar power plants, particularly in arid and semi-arid regions. An understanding of dust-induced performance degradation provides valuable guidance for the development of advanced anti-soiling coatings, optimized cleaning strategies, and reliable soiling prediction models to enhance the long-term performance of photovoltaic systems. Therefore, the present study investigates the morphological characteristics and elemental composition of dust collected from nine representative industrial and non-industrial solar power plant locations in Rajasthan, India, using Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray Spectroscopy (EDS). Multi-scale SEM analysis (10KX–100KX; 200 nm–2 μm) revealed highly heterogeneous, densely agglomerated particles with a broad size distribution. Fine particles adhered to larger particles, confirming secondary agglomeration. EDS analysis identified C, Si, Al, Ca, and Fe as the dominant elements. The combined SEM–EDS observations suggest that silica-rich agglomerated fine particles are likely to enhance light scattering and reduce optical transmittance, whereas carbon-rich particles may increase solar radiation absorption, potentially elevating module operating temperature. The paper discusses the dust properties from the nine locations and the feasible cleaning mechanisms as per the characteristics.

Keywords: *Photovoltaic modules; Dust soiling; SEM; EDS; Dust morphology; Elemental composition; Optical transmittance.*

ICAPST-2026-RSES-303607

Electron-Transport-Layer-Dependent Ionic Screening in Planar $MAPbI_3$ Solar Cells: Separating Electronic and Ionic Contributions

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ABSTRACT

Mobile ionic defects redistribute under bias in metal-halide perovskite solar cells, screening the internal electrostatic field and contributing to current–voltage hysteresis. Electron-transport layers (ETLs) are commonly compared using electronic criteria, while their influence on ionic response is less often separated. This study examines whether an ETL change that is electronically neutral to favourable can nevertheless reduce device performance when ion redistribution is included. Coupled drift-diffusion and Poisson–Nernst–Planck calculations were performed for a planar FTO/ZnO/AZO/$MAPbI_3$/spiro-OMeTAD cell. The perovskite Shockley–Read–Hall lifetime was calibrated against four reported photovoltaic parameters, reproducing them within 1.3%; the digitised hysteresis degree of 0.0912 independently constrained the ionic model. A comparison architecture with a 100 meV lower ETL electron affinity, represented by $Zn_{0.9}Ni_{0.1}O$, was evaluated across 52 matched parameter pairs with ion-free controls. Without mobile ions, the efficiency difference is only −0.017 percentage points, with a small photocurrent advantage for NiZnO/ZnO. In the hysteresis-compatible regime, the model predicts −0.4 ± 0.2 percentage points, predominantly as fill-factor loss, with approximately 95% (91–99%) assigned to the ionic contribution. Because the reference scan rate is unavailable, absolute ionic densities remain conditional. The 100 meV offset is an assumed model parameter, and experimental verification is required.

Keywords: *Perovskite Solar Cells; Electron-Transport Layer; Mobile Ion Migration; Ionic Screening; Current-Voltage Hysteresis; Drift-Diffusion Simulation.*

ICAPST-2026-RSES-350502

Numerical Simulation and Performance Optimization of Confined Lead-Free Planar Perovskite Solar Cells

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ABSTRACT

The urgent demand for sustainable and eco-friendly energy technologies has accelerated the development of perovskite solar cells (PSCs) as promising candidates due to their remarkable optoelectronic properties and cost-effective fabrication. However, the toxicity of lead-based perovskites poses severe environmental and health concerns, driving the exploration of lead-free alternatives such as tin-, bismuth-, and antimony-based perovskites. This study focuses on the performance optimization of lead-free planar perovskite solar cells under a confined model, integrating optical and electrical simulations to identify design strategies that enhance device efficiency. The transfer matrix method (TMM) was employed to model light absorption, while drift-diffusion simulations were applied to analyse charge transport and recombination mechanisms. Key parameters, including absorber thickness, band alignment, and transport layer properties, were systematically optimized. Results revealed an optimal perovskite thickness of 75 nm, achieving a simulated efficiency of approximately 21%, significantly higher than reported experimental values (2–3%). The findings highlight the potential of confined modelling in guiding material engineering and device design for next-generation, stable, and non-toxic perovskite solar cells.

Keywords: *Lead-free perovskite solar cells, Transfer Matrix Method (TMM), Planar heterojunction, Sustainable photovoltaics*

ICAPST-2026-RSES-412805

Optimizing Dual Absorber Layers for Above 30% Efficient Lead-Free 2D/3D Perovskite Solar Cells: A SCAPS-1D Modeling Approach

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ABSTRACT

Perovskite solar cells have attracted considerable attention as next-generation photovoltaic devices owing to their exceptional efficiency, tunable optoelectronic properties, and low fabrication cost. Nevertheless, the long-term operational stability of conventional three-dimensional (3D) perovskite solar cells remains a major challenge due to their susceptibility to moisture, thermal stress, and interfacial charge recombination. In this study, a novel bilayer 2D/3D perovskite solar cell with the architecture Al/FTO/ZnO/ABL1/ABL2/NiO/Au is proposed and systematically investigated using SCAPS-1D. The incorporation of a 2D perovskite layer (ABL2) at the absorber interface effectively passivates defects, suppresses non-radiative recombination, and enhances environmental stability, whereas the 3D perovskite layer functions as the primary light absorber with superior carrier generation. The effects of absorber thickness, bandgap, defect density, doping concentration, interface defect states, on the photovoltaic performance are comprehensively analyzed to determine the optimum device configuration with power conversion efficiency 32.04% and Voc open circuit voltage is 1.2196 volt. The optimized bilayer structure exhibits enhanced light harvesting, efficient charge separation, reduced recombination losses, and improved carrier transport, leading to significant enhancement in overall power conversion efficiency. These findings demonstrate that engineering a 2D/3D perovskite heterojunction solar cell provides an effective strategy for realizing high-efficiency and durable perovskite solar cells.

Keywords: *SCAPS-1D, Interface Defect Density, Perovskite heterojunction Solar cell (PHSC), Toxicity.*

ICAPST-2026-RSES-441012

Experimental Studies and Analysis of Drying of Bitter Neem Leaves *(Azadirachta Indica)* in a Small-Size Portable Solar Dryer

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ABSTRACT

Preservation of medicinal plants through drying necessitates efficient drying systems that dehydrate the samples effectively using minimal energy input without compromising on the quality of the samples. Bitter neem leaves (Azadirachta indica) are extensively used in Indian traditional medicine for uses such as blood cleansing, strengthening immunity, digestion improvement, mouthwash, skin and scalp treatment, and control of blood glucose level; however, due to the high moisture level in these samples, they are highly susceptible to post-harvest decay in storage period. This paper presents experimental investigation of the solar drying of bitter neem leaves. Drying of a 250 g sample of bitter neem was done using a solar dryer and the final mass was 188 g, representing a total mass reduction of 62 g, dehydration ratio of 1.33, and an average drying rate of 0.01163 kg/h. The solar radiation values during the drying time were between 351 and 703 W/m², with an average value of 591.67 W/m². Thermal and exergy analysis was conducted to measure the performance of the dryer, with evaluation of the quality of the dried leaves in terms of residual moisture, colour, and microbial condition with subsequent storage in ambient condition.

Keywords: *Bitter neem, solar drying, drying kinetics, energy–exergy analysis, medicinal plant preservation, solar energy.*

ICAPST-2026-RSES-515668

Metal-Organic Nanotube (MONT) as a Photocatalyst for the Visible-Light Driven Selective Dye Degradation

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ABSTRACT

In the 21st century one of the major challenges living beings are facing is water pollution. Dyes are one of the major contributors due to its extensive usage in industries. Metal organic nanotubes (MONTs) can be useful for such dye degradation application. MONTs generally possesses tubular shaped one-dimensional nanochannels and can exhibit exciting electronic and conductive properties due to the better e-h separation. However, stabilization of such class of materials are challenging.

Design and synthesis of a new MONT, **HNBGU-1**, employing a rigid and *syn*-oriented flexible organic linker is presented here. **HNBGU-1** is water-stable, semiconducting (band gap ~ 2.68 eV), and can selectively degrade high concentrations of Congo red (CR) (~99%) and crystal violet (CV) (~82%) dyes via advanced oxidation process (AOP) under sunlight (**Figure 1**). Our thorough optical studies indicate that organic dye molecules in high concentrations generally exist in aggregated state inside polar solvents like water. The low energy band at ~650 nm in the PL spectra confirms the aggregation of CR dye. However, the dyes having flexible structure can easily go back to the disaggregated state in the presence of catalyst. This allows better catalyst-substrate interaction, which consequently leads to the observation of higher photocatalytic degradation under light.

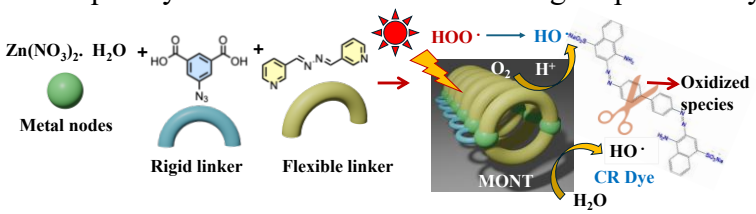


Figure 1: Schematic representation of design of a MONT HNBGU-1

Keywords: *MOF, MONTs, Dyes, Photocatalysis, Dye degradation.*

ICAPST-2026-RSES-524562

Performance study of Passive Solar Still with mixing Commercial Coffee Powder

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ABSTRACT

In Solar distillation, solar energy is used to evaporate water and subsequently condense the vapour to obtain distilled water. Modern solar stills heavily rely on inorganic nanoparticles (e.g., graphene oxide, Al_2O_3, CuO) to maximize light absorption and thermal conversion. These materials have high production costs, environmental concerns and carry cytotoxic risks. Commercial coffee powder (CCP) is zero-cost, and non-toxic, eco-friendly organic alternative. In the present study CCP is selected as an easily available light-absorbing Material, and its influence on the performance of a passive solar still (PSS) is measured by the volume of distilled water produced and the total Dissolved solids (TDS) before and after the desalination process. Two different concentrations of CCP 0.1%, and 0.5%, were Investigated using an initial water volume of 1000 ml. The experiments were carried out for approximately 5–6 hours under solar radiation. The feeding water TDS, which were 480, 330 and 530 Parts per million (PPM) for 0%, 0.1%, and 0.5% concentration of CCP reduced to 120, 50 and 90 PPM in the solar desalination process. The highest distilled water output 0.865 L was obtained for 0.5% concentration of CCP. These primary investigations infer the effectiveness of CCP in increasing the output.

Keywords: *Solar desalination, Passive solar still, Coffee powder, Distilled water*

ICAPST-2026-RSES-528114

Component-Wise Calculation of Heat Gain for Building Envelope and Suggestive Passive Cooling Measures for Enhanced Energy Efficiency

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ABSTRACT

Climate extremes and increasing demands for thermal comfort are responsible for increased energy consumption in buildings. By calculating heat gain from different components of building envelope appropriate passive measures can play an important role in improving the thermal comfort and energy efficiency of buildings. In present study theoretical heat gain for a residential building located (25.10^{o}N latitude) in Kota were performed. CLTD/SCL/GLF method from ASHRAE 1997 to estimate heat gains through the roof, walls, windows, door, infiltration, and ventilation. The calculated total sensible heat gain was 45,693 W, with the roof contributing approximately 55% and walls 35% of the total load. The building has a low window-to-wall ratio (WWR) of 3.8%, window-related heat gain was considerably lower than that of the roof and walls. The calculations have been performed for hot climatic region by varying the different parameters such as window to wall ratios, insulation and shades.

Keywords: *Passive measures, building envelope, thermal comfort, cooling load, energy efficiency, heat gain.*

ICAPST-2026-RSES-530930

Comparative Study on the Photovoltaic Performance of SnO_2–CdS Nanostructured Solar Cells Fabricated by M-CBD and CBD Techniques

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ABSTRACT

In this work, SnO_2–CdS thin films were synthesized using both conventional chemical bath deposition (CBD) and modified chemical bath deposition (M-CBD) methods to develop cost-effective photoelectrode materials for solar cell applications. The structural, optical, and morphological characteristics of the deposited films were investigated using X-ray diffraction (XRD), UV–Visible spectroscopy, field-emission scanning electron microscopy (FESEM), and transmission electron microscopy (TEM). Optical studies confirmed the light absorption behaviour of the prepared films, while XRD analysis was employed to evaluate their crystallinity and estimate the average crystallite size. The crystallite sizes were found to be approximately 20 nm for the M-CBD sample and 16 nm for the CBD sample. The photovoltaic performance of the fabricated solar cells is strongly influenced by factors such as crystallinity, optical absorption, and charge carrier transport. A comparative analysis of the fabricated devices revealed that the M-CBD-derived solar cell exhibited enhanced photovoltaic characteristics, delivering a short-circuit current (Isc) of 4.35 mA and a power conversion efficiency (η) of 2.72%, whereas the CBD-based device achieved an Isc of 2.18 mA and an efficiency of (η) 1.40%. These findings demonstrate that the M-CBD technique is more effective in producing high-quality SnO_2–CdS thin films with improved photovoltaic performance.

Keywords: *Solar Cell, XRD, FESEM, TEM, UV-Visible*

ICAPST-2026-RSES-652539

Modeling and Comparative Study of PV Panel Temperature and Energy Yield Under Control and Crop-Based Agrivoltaic Conditions

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ABSTRACT

Agrivoltaic systems combine solar energy generation and agricultural production on the same area of land. Crops grown beneath solar panels can alter the local microclimate and may lower the operating temperature of PV cells. Since PV panel efficiency decreases as cell temperature rises, this cooling effect can increase electrical output. This paper proposes a Python-based model for calculating PV cell temperature and energy yield under two operating conditions: a control without crops and a crop-based agrivoltaic condition. The model calculates plane-of-array irradiance, PV cell temperature, temperature-corrected efficiency, DC and AC power, normalized PV output, and specific energy yield. The crop condition is reflected through a reduction in PV cell temperature due to crop related cooling effects and lower heat accumulation beneath the panels. The model is validated using published agrivoltaic researches that report PV temperature reduction, efficiency changes, or energy-yield improvements under crop and non-crop conditions. The comparison helps assess whether the model can reproduce the main trends reported in the literature. This work provides a clear and practical framework for understanding that crops beneath PV panels influence PV temperature and electrical performance. The proposed approach can support future agrivoltaic design, performance assessment, and site-specific energy-yield estimation.

Keywords: *Agrivoltaics, PV panel temperature, Crop-induced cooling, Energy yield, modelling, validation*.

ICAPST-2026-RSES-654126

Study of a Developed Small-Size Solar Water Heater for Cottage Textile Industry

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ABSTRACT

The energy expenditure in dyeing can easily be partially met by the use of solar water heaters. Presently the solar water heaters available in the market are quite large (capacity of 100 to 200 liters) and expensive (INR 20,000 to 40,000), which are unaffordable by communities involved in cottage textile industries. Therefore, in the present work, a small-size solar water heater has been designed which can supply around 2-3 liters of hot water at a time. This paper presents the design details and experimental studies of the developed solar water heater. The experimental studies on the developed solar water heater indicate that it can be used throughout the year; even for a winter day when the ambient temperatures are below 19°C, the temperature of water around 60°C can be easily attained. Around 10-15 liters of hot water can be withdrawn from the system throughout the day. For best performance the solar water heater should be placed at a 0° tilt in summers, a 20° tilt in March and September, and around 40-60° in winters for latitudes 20-25°N.

Keywords: *Solar water heater, cottage textile industry, dyes, energy expenditure, energy savings, solar collector.*

ICAPST-2026-RSES-676573

Experimental Thermal Analysis of Photovoltaic Integrated Solar Chimney for Underpass Tunnel

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ABSTRACT

Underpass Tunnels are necessary civil structure to ease out the traffic and to reduce travel length as in some places where constraints like hill, rail track, roads, bridges, rivers etc. exist to passthrough. Whenever, travellers (pedestrian & drivers) move through the underpass tunnel face problems of trapped heat & smoke, sudden reduction of illumination, and traffic congestion. Photovoltaic integrated Solar Chimney (PVSC) posses a viable solution which can generate the electrical power to run DC fans for forced draft and to run LED lighting system for proper illumination inside the underpass tunnel.

An experimental analysis has been done on 'Diamond Jubilee Underpass Tunnel (DJUT)' situated in MNNIT Allahabad of dimensions (covered with 1.6 cm thick semi-transparent canopy sheet) are Length 325 m, width 10.18 m & height (at centre) 4.04 m with pillar's dimension (49×49 cm^2) and on its 'scaled down model integrated PVSC (300 cm×70 cm with height at centre 40 cm & 20 W_p PV panel with two 12v DC fans)'.

The result show that PVSC in underpass tunnel, effectively improves the ventilation to remove the heat and smoke and the generated power can be utilized for illumination inside to improve the visibility inside the underpass tunnel.

Keywords: *Underpass Tunnel, Solar Chimney, Photovoltaic, Ventilation, Thermal Study.*

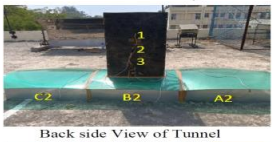
Graphical Abstract:



Fig. a) Diamond Jubilee Underpass Tunnel Entrance, (b) Side view of Tunnel (at MNNIT Allahabad)

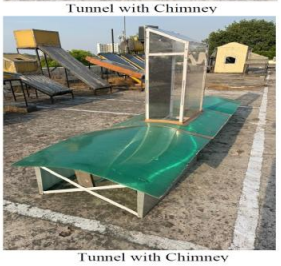


Tunnel with Chimney

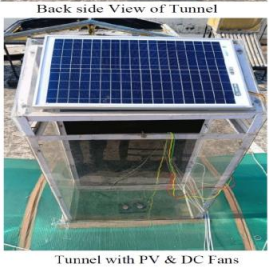


Back side View of Tunnel

Dimensions of Solar Chimney	
Parameters	Values (cm)
Breadth of Chimney	34
Width of Chimney	63
Height of absorbing wall	125
Height of glazing wall	100



Tunnel with Chimney



Tunnel with PV & DC Fans

Dimensions of each part of Duct (Prototype)	
Parameters	Values (cm)
Length	100
Width	70
Height (Without Canopy)	30
Height (With Canopy)	40

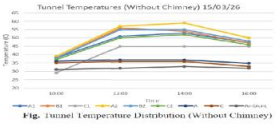


Fig. Tunnel Temperature Distribution (Without Chimney)

ICAPST-2026-RSES-760719

Recent Advances in Heat Transfer and Storage Materials for Solar Power Systems

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ABSTRACT

The demand for electricity has increased gradually in the past few years. This increasing demand is being fulfilled from renewable as well as non-renewable energy sources. Among numerous available renewable energy sources, the most promising and extensively used renewable energy source is solar energy. One of the drawbacks of solar energy is that it is intermittent and variable because solar radiation doesn't occur all day long. The thermal energy storage system can well solve this problem, store excess thermal energy when solar radiation is high, release when solar energy is not available and/or is not enough. The properties, advantages and limitations of a large number of heat transfer fluids and thermal energy storage materials are thoroughly reviewed in the present work. Liquid metals like liquid sodium, sodium potassium alloy, lead–bismuth eutectic and tin, molten salts like sodium nitrate, potassium nitrate, sodium chloride, potassium chloride and magnesium chloride, cobalt oxide, and nanomaterials, like aluminum oxide, calcium oxide and silicon dioxide nanoparticles, are the subjects of the present work. Also, conventional heat transfer media such as water and steam are discussed. They are explored for their potential thermal energy storage applications and their ability to be efficiently and reliably used in solar power systems.

Keywords: *Heat transfer fluids, Liquid metals, Metal oxides, Molten salts, Concentrated solar power system, Thermal-energy storage Material.*

ICAPST-2026-RSES-840780

Investigation of a Flexible and Hierarchically Porous Polydimethylsiloxane Coating for Passive Daytime Radiative Cooling

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ABSTRACT

Passive radiative cooling is the technology that can cool terrestrial objects by radiating heat to ultra-cold outer space via the atmospheric window. For subambient daytime radiative cooling, a coating should be highly reflective in the solar spectrum (0.3-2.5 μm) and strongly emissive in the Infra-Red region. To obtain such a kind of coating, an engineered structure is required that can be obtained by high-cost and complex fabrication processes. This study describes a straightforward fabrication process of a hierarchically porous polymer coating by a sacrificial micro-sugar template with zero toxic residue. Reflectance spectra of reported hierarchically porous polymer film exhibit sufficiently high solar reflectance up to 0.95 in UV and 0.90 in the visible region. FTIR spectra with absorption peaks in the atmospheric transparency window (8–13 μm) that correspond to vibrational modes of polydimethylsiloxane control superior longwave infrared thermal emittance, achieving values up to 0.98. Furthermore, the coating is stable under UV exposure and superhydrophobic in outdoor conditions, which confirms the self-cleaning capability of the reported porous polymer coating.

Keywords: *Radiative Cooling, Subambient, Ultra-cold, Superhydrophobic, self-cleaning*

ICAPST-2026-RSES-996464

Effect of Annealing Temperature on the Structural and Optical Properties of Sol-Gel Derived Cu_2ZnSnS_4 (CZTS) Thin Films

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ABSTRACT

Cu_2ZnSnS_4 (CZTS) is a promising absorber material for thin-film photovoltaic applications due to its suitable optical properties and earth-abundant constituent elements. In this work, CZTS thin films were prepared by a sol-gel spin-coating method using chloride-based precursor solutions. The films were deposited at a spin speed of 3000 rpm and annealed at temperatures ranging from 250–600 °C at intervals of 50 °C. The influence of annealing temperature on the structural and optical properties of CZTS thin films was investigated. Structural characterization was performed using X-ray diffraction (XRD) to examine phase evolution and crystallinity. The XRD patterns exhibited a prominent (112) diffraction peak around $2\theta \approx 28.48°$, characteristic of the kesterite CZTS structure. Crystallinity improved with increasing annealing temperature, as indicated by enhanced and sharper diffraction features. Optical measurements were carried out using UV–Vis spectroscopy to study absorption and optical band-gap characteristics. The optical band gap was approximately 1.53 eV. The results indicate that annealing temperature plays an important role in controlling the structural and optical properties of CZTS thin films and provides useful insight for optimizing their properties for potential photovoltaic and optoelectronic applications.

Keywords: *Cu_2ZnSnS_4 (CZTS), Sol-gel method, Spin coating, Annealing, Thin films*

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IMPORTANT DATES

Abstract Submission: 1 July 2026
Full-length Paper Submission: 15 August 2026
Early Bird Registration: August 31, 2026
Conference Dates: October 22–24, 2026

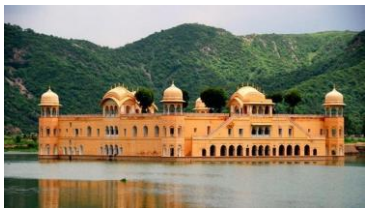
REGISTRATION FEE (EARLY BIRD)

Category	Indian & SAARC Participants (INR)	Foreign Participants (USD)
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Academician / Faculty	3000	250
Industry person	4000	350
Attendees	1000	100

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