1st DAE CONCLAVE, 2024

22 - 26 October, 2024

NISER BHUBANESWAR

A PLATINUM JUBILEE CELEBRATION

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Prof. Palok Aich (Dean R&D, NISER)

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डॉ. अजित कुमार मोहान्ती
Dr. Ajit Kumar Mohanty

भारत सरकार
Government of India

अध्यक्ष, परमाणु ऊर्जा आयोग
व
सचिव, परमाणु ऊर्जा विभाग
Chairman, Atomic Energy Commission
&
Secretary, Department of Atomic Energy

FOREWORD

With deep satisfaction, I write this foreword for the 1st Department of Atomic Energy (DAE) Conclave at the National Institute of Science Education and Research from 22nd to 26th October 2024.

DAE entered its 70th year of formation this year. The conclave forms an integral part of a series of efforts to commemorate this occasion by celebrating our achievements and showcasing the plans to contribute to our nation's vision for Amrit Kaal.

The conclave particularly encourages the interaction of scientists, engineers and researchers from all the units of DAE on a single platform. The scientific program encompasses all areas covered within DAE like the nuclear power programme, health care, cutting-edge research, development and application in the area of advanced technologies, materials, radiation-based technologies, basic and directed research, efforts towards development and deployment of technologies, knowledge management, capacity building and human resource development. I believe this conclave will provide the impetus to stimulate further study and research in all these areas.

The conclave will provide a unique platform for a bird's eye view of DAE's programs in its various units. In addition to showcasing the scientific and technological developments, it will enhance interdisciplinary and collaborative research work within the DAE. The scientific program has a good mixture of young and experienced speakers and presenters. The keynotes are the highlights of this high-quality scientific program. All these will facilitate both the sharing of knowledge and the garnering of advice for the future.

The scientific contributions by members of all units of DAE in the form of talks, posters, and exhibits will surely help make the conclave an outstanding success. I thank the advisory, program, and local organising committees for their diligent work. I also thank all the presenters and participants for their contributions to the program. I hope such a conclave will be an annual event of DAE, with all units having the opportunity to host it in the coming years. This will also be another way for the members of the DAE family to visit the sister units and appreciate their unit-level contributions to the vision and missions of DAE.

In the end, I am sure you will enjoy meeting up with old colleagues and forging links with new ones. I hope you also have a chance to explore some of Odisha's historical areas and dance forms and enjoy the local food delicacies. I once again thank all the units of DAE for active participation at the conclave and urge everyone in the DAE family to continue contributing to the nation's service in the true spirit of "Atoms in service of the nation". This way, collectively, we will fulfil our responsibilities towards a Viksit Bharat.

Ajit Kumar Mohanty
(Ajit Kumar Mohanty)

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राष्ट्रीय विज्ञान शिक्षा एवं अनुसंधान संस्थान, भुवनेश्वर
(परमाणु ऊर्जा विभाग, भारत सरकार का एक स्वयं शासित संस्थान)
National Institute of Science Education and Research, Bhubaneswar
(An autonomous Institution under Department of Atomic Energy, Govt. of India)

प्रो. हीरेन्द्र नाथ घोष,
एफ एन ए, एफ ए एस सी, एफ एन ए एस सी, एफ एन ए ई, जे.सी. बोस नेशनल फेलो
निदेशक

Prof. Hirendra Nath Ghosh,
FNA, FASc, FNASc, FNAE, J.C. Bose National Fellow
Director

FOREWORD

In my mind, the **1st DAE (Department of Atomic Energy) Conclave 2024** is set to be a landmark event, bringing together experts, policymakers, researchers, and industry leaders to explore the latest advancements and future directions in the field of atomic energy. The timing could not be better than organizing the 1st DAE Conclave, aka the platinum jubilee celebration of DAE, during the Amrut kaal of India.

As the world transitions toward cleaner and more sustainable energy solutions, nuclear power emerges as a crucial pillar of this global energy mix. The conclave aims to foster dialogue, innovation, and collaboration to unlock the full potential of atomic energy for peaceful purposes.

With its long-standing commitment to nuclear energy for peaceful applications, India has been at the forefront of research, development, and deployment in this critical sector. From energy generation to healthcare, agriculture, and space exploration, nuclear technology has touched various aspects of modern life, making this conclave a platform to highlight these contributions.

The DAE Conclave 2024 will also focus on emerging trends like small modular reactors (SMRs), nuclear fusion, advanced safety protocols, and next-generation nuclear technologies.

Through insightful discussions, cutting-edge presentations, and strategic networking, the event will provide a space to reflect on the achievements of the past while charting the course for future innovations.

This foreword is a testament to the DAE's unwavering commitment to fostering scientific excellence, supporting national development, and contributing to global efforts in addressing climate change and sustainable energy challenges. We look forward to the discussions and outcomes from this first conclave, which will set the tone for future collaborations and developments to set the path for Vikshit Bharat.

I welcome all conclave participants and look forward to hosting you all at NISER. I wish all participants a scientifically fruitful and productive time during the conclave.

(Hirendra Nath Ghosh)

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हमेशा हिन्दी में पत्र व्यवहार करके देश का गौरव बढ़ाएं

राष्ट्रीय विज्ञान शिक्षा एवं अनुसंधान संस्थान, भुवनेश्वर
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National Institute of Science Education and Research, Bhubaneswar
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Palok Aich, PhD
Professor & Dean (R&D), NISER
Convener, 1st DAE Conclave, Platinum Jubilee Celebration

Thoughts that transcended into Convener's message

The sky is not even the limit, especially when something is happening for the first time in 70 years that too in DAE at NISER. It is going to create a story that is real. The 1st DAE Conclave and Platinum Jubilee celebration coincide and converge to make history.

Why do we decide to have the conclave? So that we come to know the members of the DAE family, we come to know what my other family members are doing and how they are doing. Can we even think of doing something jointly to take the scientific leaps to create novel technology that is purely ours? The plausible path and the outcome reminded me of **Kaprekar's constant (KC)**, a well-known number in recreational mathematics.

The Kaprekar constant can be thought of metaphorically in relation to scientific collaboration, where iterative processes, collective efforts, and the pursuit of structured knowledge leads to a concurrent or significant result. Here are a few ways this analogy can be drawn:

1. Iterative Process of Discovery
2. Role of Structure and Methodology
3. Convergence to a Significant Result
4. Collaboration Across Disciplines
5. Self-Correction

In summary, the Kaprekar constant metaphorically parallels scientific collaboration's structured, iterative, and concurrent nature, where diverse efforts and ideas come together to produce a meaningful and impactful result.

In this conclave, when we are talking about collaborative science to achieve Vikshit Bharat's goals via nuclear science, we can see which collaborations lead to our goals faster by knowing each other's work better.

We should not forget to follow four basic stages of practicing science: Curiosity, Creativity, Constructive Criticism, and Consilience, especially the consilience.

Consilience is the idea that evidence from different sources can be combined to reach a successful outcome, which is precisely the objective of the 1st DAE Conclave 2024. Following the path of Kaprekar and targeting the Consilience to decide on fruitful collaborations, we can make a transition that can guarantee the transcendence to a true VIKHSIT BHARAT to become a self-sustainable Bharat.

As a convener of this unique august gathering, I feel privileged and honored and wish the success of this event with an actual team game. This event would not have been possible without the support of my colleagues and students of NISER and especially Prof Hirendra Nath Ghosh, the Director, NISER. I also sincerely thank the Chairman, AEC/Secretary, DAE, and the Director, NISER, for their patronization. I hope you will all cherish the event and will leave a lifelong impact on every participant's life. While credit of the success is yours the debit of mistakes is on me.

Palok Aich

(Prof. Palok Aich)

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हमेशा हिन्दी में पत्र व्यवहार करके देश का गौरव बढ़ाएं

Programme Schedule

Day 1 (22nd October, 2024)

Registration			
Inaugural Session	9.30-10.30	Prof. Palok Aich (NISER) Shri Kamlesh Nilkanth Vyas (DAE) Prof. Anil Kakodkar (DAE) Prof. Ajit Kumar Mohanty (DAE) Prof. Krishnaswamy Vijayaraghavan (NCBS) Prof. Hirendra Nath Ghosh (NISER)	
Session 1	**Session Chair: Prof. A K Mohanty (Chairman, AEC and Secretary, DAE)**		
	11.00-11.30	Prof. Anil Kakodkar (DAE)	Pursuing Scientific Research in A Mission Mode Organisation
	11:30-12:00	Prof. K Vijayaraghavan (NCBS)	Shaping Life Sciences for the Future
	12:00-12:30	Prof. Ashoke Sen (ICTS)	Gravitational Wave Tails from Soft Theorem
Lunch Break			
Session 2	**Session Chair: Shri Vivek Bhasin (Director, BARC)**		
	14:00-14:30	Prof. J P Mittal (CEBS)	Agony and Ecstasy of Radiation Research
	14:30-15:00	Prof. Mahan Mj (TIFR)	Random Hyperbolic Geometry
	15:00-15:30	Prof. Sudeep Gupta (TMC)	Delivering Affordable Cancer Care with High Quality and at Scale in India
Tea/Coffee Break			
Session 3	**Session Chair: Prof. V Ravindran (Director, IMSc)**		
	16:00-16:30	Prof. Bedangadas Mohanty (NISER)	Recreating microsecond old universe conditions in the laboratory science and societal benefits.
	16:30-17:00	Prof. Jayaram N Chengalur (TIFR)	Probing galaxies and the Cosmos with the Giant Metrewave Radio Telescope
Session 4	**Session Chair: Prof. Hirendra Nath Ghosh (Director, NISER)**		
	17:15-18:00	Shri K N Vyas (DAE) (Evening lecture)	Global warming and relevance of atomic energy
Banquet Dinner			

Day 2 (23rd October, 2024)

Session 5	**Session Chair: Prof. U Kamachi Mudali (VC, HBNI)**		
	9.30-10.00	Shri K N Vyas (DAE)	A Perspective on DAE's Many Strengths and A Few Weaknesses
	10:00-10:30	Prof. Pankaj Chaturvedi (ACTREC, TMC)	Simple Solution for Complex Problems in Cancer - Tata Memorial Centre experience
Tea/Coffee Break			
Session 6	**Session Chair: Prof. V Chandrasekhar (TIFR, Hyderabad)**		
	11:00-11:30	Prof. A K Tyagi (HBNI)	Development of materials, processes and products for nuclear sector: Role of basic sciences
	11:30-12:00	Prof. M Krishnamurthy (TIFR-H)	Relativistic electron acceleration with mJ lasers at Multi kHz repetition rates
	12:00-12:30	Prof. Vidita Vaidya (TIFR)	Imprints of Early Adversity - how the brain and body keep score
Lunch Break			
Session 7	**Session Chair: Prof. Gautam Bhattacharyya (Director, SINP)**		
	14:00-14:30	Prof. Aditi Sen De (HRI)	Recent developments in quantum technologies
	14:30-15:00	Prof. Aradhana Shrivastava (BARC)	Recent Advances in Nuclear Physics Research
	15:00-15:30	Prof. S M Yusuf (BARC)	Spin Entanglement and Quantum Technology
Tea/Coffee Break			
Session 8 (LH – 5, Library Complex)	**Session Chair: Shri K Mahapatra (Director, DCSEM)**		
	16:00-16:30	Dr. Komal Kapoor (NFC)	Gearing up for supply of fuel and core materials for Nuclear Power Program for the next two decades
	16:30-17:00	Dr. Venkatesh Raman (IMSc)	Space Efficient Suffix Trees
	17:00-18:30	POSTER/EXHIBITS	
	18:30-19:30	CULTURAL PROGRAMME	
Dinner			

Day 3 (24th October, 2024)

Session 9	**Session Chair: Shri Pradip Mukherjee (Chief Executive, BRIT)**		
	09:30-10:00	Prof. Shashank Chaturvedi (IPR)	Science-Based Development of Plasma & Fusion Technologies
	10:00-10:30	Prof. Dheeraj Pande (AMD)	Science of mineral exploration and mining
Tea/Coffee Break			
Session 10	**Session Chair: Dr. Unmesh D Malshe (Director, RRCAT)**		
	11:00-11:30	Prof. Satya Ram Mishra (RRCAT)	Development of quantum technologies using cold atoms
	11:30-12:00	Prof. Tapas Ganguly (RRCAT)	Science with Synchrotron facility
	12:00-12:30	Prof. Vandana Nanal (TIFR)	Why do we need to worry about Gender inequality in science?
Lunch Break			
	14:00-19:00	EXCURSION TO KONARK	
Dinner			

Day 4 (25th October, 2024)

Session 11	**Session Chair: Dr. C G Karhadkar (Director, IGCAR)**		
	09:30-10:00	Prof. B Venkatraman (IGCAR)	Nuclear Power and Fast Reactor Program
	10:00-10:30	Dr. V Rajesh (NPCIL)	Nuclear Power: Present and Future
Tea/Coffee Break			
Session 12	**Session Chair: Prof. K K Nanda (Director, IOP)**		
	11:00-11:20	Dr. Sanjib Kumar Agarwalla (IOP)	Neutrino Tomography of Earth
	11:20-11:40	Dr. Tapan Mishra (NISER)	Signatures of non-trivial doublon formation using a quantum computer
	11:40-12:00	Dr. Akashrup Banerjee (SINP)	First results with India's Nuclear Astrophysics Accelerator: FRENA
	12:00-12:20	Prof. C Gunanathan (NISER)	Sustainable Catalysis Enabled by Metal-Ligand Cooperation
Lunch Break			
Session 13	**Session Chair: Prof. Kalobaran Maity (TIFR, Mumbai)**		
	14:00-14:30	Dr. Sangram Bagh (SINP)	Genetically Engineered Bacteria Identify Prime Numbers, Vowels and Answer Math Questions
	14:30-15:00	Prof. Vaishali Naik (VECC)	Radioactive Ion Beams - covering the spectrum from Cosmos to Hadron Therapy
Tea/Coffee Break			
Session 14	**Session Chair: Prof. Shreepad Karmalkar (Director, IIT-BBS)**		
	15:30-16:00	Dr. B.R Mishra (IREL)	Rare Earths: Critical Material for Energy Transition
	16:00-16:20	Dr. Nafees Ahmed V (BARC)	Development of Hydrogen Technologies in BARC
	16:20-16:40	Smt. Manisha Rathee (HWB)	Heavy Water Technologies and Diversified Activities
	16:40-18:00	POSTER/EXHIBITS	
	18:00-19:00	CULTURAL PROGRAMME	
Dinner			

Day 5 (26th October, 2024)

Session 15	**Session Chair: Prof. Ashok Ganguli (Director, IISER Berhampur)**		
	09:30-10:00	Prof. R Chidambaram (DAE)	DAE Centric Keynote
	10:00-10:30	Prof. A K Nayak (NCPW)	Atomic Energy and way forward
Tea/Coffee Break			
Session 16	**Session Chair: Prof. Dileep Jatkar (Director, HRI)**		
	11:00-11:20	Dr. Manjusha Dixit (NISER)	EEF1A2 Drives Dual- Mode Angiogenesis in Breast Cancer in Normoxia and via a HIF1A-Driven Feedback Loop in Hypoxia
	11:20-11:40	Prof. Sandip Dhara (IGCAR)	Radiation Damage Studies at Materials Science Group
	11:40-12:00	Prof. Jacinta S D'Souza (CEBS)	A-Kinase anchoring Protein scaffolds: changing partners for different roles
	12:00-12:20	Dr. Manas Ranjan Sahoo (NISER)	On a Complex Sequence of Vanishing Moments
Lunch Break			
	14:00-15:30	POSTER/EXHIBITS	
Closing Session	15:30-16:30	Prof. Palok Aich (NISER) Host of next DAE Conclave Prof. R Chidambaram (DAE) Prof. Hirendra Nath Ghosh (NISER) Prof. Bedangadas Mohanty (NISER)	

INVITED SPEAKERS

Pursuing Scientific Research in A Mission Mode Organisation

Prof. Anil Kakodkar

Department of Atomic Energy (DAE), Government of India

Prof. A Kakodkar is an eminent nuclear physicist at the Department of Atomic Energy (DAE), Government of India. He was the Chairman of the Atomic Energy Commission of India and the Secretary to the Government of India. He was the Director of the Bhabha Atomic Research Centre. He was awarded the Padma Shri (1998), Padma Bhushan (1999) and Padma Vibhushan (2009). He played a key role in India's nuclear tests in 1974 and 1998. He has been involved in the development of advanced reactor technologies, including the Advanced Heavy Water Reactor (AHWR). He continues to be actively involved in promoting sustainable and self-reliant energy solutions for India. He is a Fellow of all the science academies of India and Indian National Academy of Engineers.

DAE has pioneered self-reliant technology for strategic autonomy in national development. Following such an approach requires co-existence of research and research translation. The synergy or, lack of it, between the two has been a matter of much debate in the past. The talk would cover some aspects of doing scientific research and technology development together from DAE perspective.

Shaping Life Sciences for the Future

Prof. K Vijay Raghavan

DAE Homi Bhabha Chair, National Centre for Biological Sciences, Tata Institute of Fundamental Research

Prof. K Vijay Raghavan is an Emeritus professor and former Director of the National Centre for Biological Sciences (NCBS), TIFR. The Government of India appointed him as the principal scientific adviser in 2018. In 2012, he was elected a Fellow of The Royal Society and in April 2014 he was elected as a foreign associate of the US National Academy of Sciences. He was appointed as the secretary of the DBT, India in 2013. He was conferred the Padma Shri on 26 January 2013 and received the Infosys Prize in the life sciences category in 2009 and the Bhatnagar Prize for Science and Technology in 1998. He is an elected fellow of TWAS, APS, Indian Academy of Sciences and Indian National Science Academy. He has also been awarded the J. C. Bose Fellowship of DST.

The world of life sciences and biotechnology is changing at a breakneck pace, propelled by discoveries through biology-driven approaches, and by the use of artificial intelligence and by computational approaches. To be globally competitive and nationally relevant will require a structured approach, which, if done correctly, will pay off in a decade or two. There is a very special role for the Department of Atomic Energy in shaping the future of biology in India. The DAE family is a powerhouse that can anchor change in a manner no other agency can. However, we need to pivot from only recognising the legitimate strengths of what we have done and are doing into ways by which we can aggressively shape the future. This will require embarking on well-defined long-term missions. Dedicated management and mission leadership will be needed for these collaborative missions. Ways of ensuring long-term support are needed. Success will come only from the missions closely collaborating with industry and the university system. I will give a few examples of the kinds of missions we can undertake and how they could be structured for maximum efficiency.

Gravitational Wave Tails from Soft Theorem

Prof. Ashoke Sen

International Centre for Theoretical Sciences, Tata Institute of Fundamental Research (TIFR)

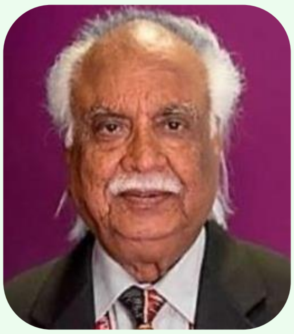
Prof. Sen is an eminent Indian theoretical physicist and distinguished professor at the International Centre for Theoretical Sciences, Bangalore. He is an honorary fellow at the National Institute of Science Education and Research, India, a Morningstar Visiting professor at MIT and a distinguished professor at the Korea Institute for Advanced Study. His main area of work is string theory. He is the recipient of the Breakthrough Prize in Fundamental Physics, Fellow of Royal Society and Infosys Prize Winner. He is awarded Padma Shri (2001), Padma Bhushan (2013), G.D. Birla Award for Scientific Research (1996), TWAS Prize (1997) and Dirac Medal (2014). He is an elected Fellow of the Indian National Science Academy and Indian Academy of Sciences.

If a set of massive objects collide in space and the fragments disperse, possibly forming black holes, then this process will emit gravitational waves. Computing the detailed gravitational wave-form associated with this process is a complicated problem, not only due to the non-linearity of gravity but also due to the fact that during the collision and subsequent fragmentation the objects could undergo complicated non-gravitational interactions. Nevertheless, the classical soft graviton theorem determines the power law falloff of the wave-form at late and early times, including logarithmic corrections, in terms of only the momenta of the incoming and outgoing objects without any reference to what transpired during the collision. In this talk I shall explain the results.

Agony and Ecstasy of Radiation Research

Prof. Jai Pal Mittal

Distinguished Professor, Chairman Academic Board Centre for Excellence in Basic Sciences, University of Mumbai - Department of Atomic Energy, Mumbai



Prof. Mittal is a Distinguished Professor at the Centre for Excellence in Basic Sciences, University of Mumbai - Department of Atomic Energy. *He is known for his research in photochemistry and radiation chemistry. He is a DAE Raja Ramanna Fellow of Bhabha Atomic Research Centre and an elected fellow of Indian National Science Academy. He is a former M.N. Saha Distinguished Professor (NASI), Bhabha Atomic Research Centre (BARC), Mumbai. He is an elected Fellow of the Indian National Science Academy, National Academy of Sciences, India, The World Academy of Sciences, and the Indian Academy of Sciences. The Government of India awarded him the Padma Shri in 2003.*

Challenges and excitement of studying unique chemical transformations on blending of High Energy Photons (energy 1MeV) with chemical compounds will be shared. Efforts to study the reactivity of transient reactive species such as e-H. atom and-OH free radicals with molecules of biological interest with Ultrafast Spectroscopic techniques such as Pulse Radiolysis will be presented. Recent studies in pico to femtosecond time scale will be discussed, with their relevance to few problems of societal interest.

Random Hyperbolic Geometry

Prof. Mahan Mj

Tata Institute of Fundamental Research (TIFR), Mumbai

Prof. Mahan Mj, prominently known as Mahan Maharaj or Swami Vidyanathananda is a Professor of Mathematics at the Tata Institute of Fundamental Research (TIFR) in Mumbai. His austere lifestyle is a perfect blend of religion and scientific quest. His work is considered a major milestone in Thurston's program, initiated almost forty years ago. In 2011, he was awarded the most prestigious Shanti Swarup Bhatnagar Award and the Infosys Prize in 2015. He is an elected Fellow of the Indian National Science Academy and the Indian Academy of Sciences. He is also a JC Bose National Fellow.

Random geometry models in probability have traditionally been in a Euclidean background, typically the Euclidean plane. Random models in a hyperbolic background are of a more recent origin. We shall survey some of the topics that have been investigated including random walks, first passage percolation and Ising models.

Delivering Affordable Cancer Care with High Quality and at Scale in India

Prof. Sudeep Gupta

Tata Memorial Centre

Prof. Sudeep Gupta is an eminent oncologist and the Director of Tata Memorial Hospital in Mumbai, India. He is the former Director of ACTREC. His areas of expertise include breast cancer, gynaecological cancers, clinical trial design, investigator-driven and industry sponsored clinical trials, tumor evolution, and endocrine treatment resistance in breast cancer. He led the landmark study which established the superiority of concurrent chemoradiation over neoadjuvant chemotherapy-surgery in locally advanced cervical cancer.

Tata Memorial Centre has pioneered models of cancer care delivery, which are based on evidence-based management and affordable and implementable solutions. It has consistently advocated and created templates for the hub-and-spoke model of care, so that patients can receive care close to their homes. TMC has also created an ecosystem for achieving high standards of excellence in training and education, clinical and translational research and public health. The keynote talk will cover these aspects of TMC functioning with appropriate examples, in the contest of social and economic imperatives of India.

Recreating Microsecond Old Universe Conditions in The Laboratory - Science and Societal Benefits

Prof. Bedangadas Mohanty

National Institute of Science Education and Research, Bhubaneswar

Prof. Bedangadas Mohanty is a Senior Professor at the National Institute of Science Education and Research, Bhubaneswar. He works in the area of experimental high energy physics. He is currently the Deputy Spokesperson of ALICE experiment at CERN, LHC and is a former Deputy Spokesperson of STAR experiment at BNL, RHIC, USA. He has been awarded the Infosys Prize in Physical Sciences for 2021. He was conferred the prestigious Shanti Swarup Bhatnagar Prize for Science and Technology in 2015. He is an elected fellow of the American Physical Society and all the three science academies in India. He is currently the J C Bose National fellow of DST.

The fundamental constituents of visible matter are quarks, gluons, and leptons. The quarks and gluons are not found to exist in a free state in nature. They are confined inside particles called hadrons. However, they were believed to be in a free state in the micro-second old Universe. We will discuss the formation of such a primordial matter of de-confined quarks and gluons in the laboratory and some of its interesting properties. Towards the end of the talk, we will also discuss some of the societal benefits which have happened due to the field of experimental high energy physics.

Probing Galaxies and The Cosmos with The Giant Metrewave Radio Telescope

Prof. Jayaram N Chengalur

Tata Institute of Fundamental Research (TIFR), Mumbai

Prof. Jayaram N Chengalur is the Distinguished Professor and the Director of TIFR-Mumbai. He is an eminent physicist whose main research focus is extragalactic astronomy, particularly studies of nearby dwarf irregular galaxies, neutral hydrogen (HI) absorption in very high redshift galaxies (the so called "damped Lyman alpha" systems). He is a Fellow of the Indian Academy of Sciences, the National Academy of Sciences, India, and the Indian National Science Academy.

The Giant Meterwave Radio Telescope (GMRT), built and operated by NCRA-TIFR is one of the most sensitive radio telescopes in the world at many of its frequencies of operation. Its recently completed upgrade ensures that the telescope will continue to maintain its international competitiveness for the immediate future. I will present some of the recent work done with the upgraded GMRT (uGMRT), with particular emphasis on the contributions that uGMRT observations have made to our understanding of how star forming galaxies evolve over cosmic time. Another area that has been of growing interest to the radio astronomy community is the study of transient sources, i.e. sources whose emission lasts for periods as short as a few milliseconds. These sources are of interest not only in themselves, but also as probes of the tenuous inter-galactic medium. I will also discuss some ongoing instrumentation work at the uGMRT aimed at providing the capability to do cutting edge transient studies.

A Perspective on DAE's Many Strengths and A Few Weaknesses

Shri K N Vyas

Department of Atomic Energy (DAE), Government of India

Shri K N Vyas is an eminent nuclear scientist and the former Director of Bhabha Atomic Research Centre. He is a distinguished Homi Bhabha Chair Professor at the Department of Atomic Energy. His work has significantly contributed to the design and development of nuclear reactor fuels, thermal hydraulics, and stress analysis of critical reactor core components. He has received several awards, including the Homi Bhabha Science and Technology Award and the Indian Nuclear Society Outstanding Service Award. He is also a Fellow of the Indian National Academy of Engineers.

Department of Atomic Energy (DAE) is a unique Department. This is not only with respect to India but even the whole world. An attempt is being made to give the speaker's perspective regarding DAE. This is with a hope that the presentation may generate discussions and also help create a stronger DAE.

Simple Solution for Complex Problems in Cancer - Tata Memorial Centre Experience

Prof. Pankaj Chaturvedi

Advanced Centre for Treatment, Research and Education in Cancer (ACTREC), Tata Memorial Centre

Prof. Pankaj Chaturvedi is the Director of Advanced Centre for Treatment, Research and Education in Cancer (ACTREC), Tata Memorial Centre. He works with union and state governments towards enhancing cancer care and control all over India. He has tremendous interest in Public Health issues especially related to tobacco, areca nut and alcohol control. He was invited as a speaker to the United Nations Summit on Non-Communicable Diseases, 2011 in New York. He has been invited as visiting faculty in 18 head and neck cancer institutions in 14 countries. He is a Fellow of the International College of Surgeons and Fellow of Association of Indian Surgeons.

Development of materials, processes and products for nuclear sector: Role of basic sciences

Prof. A K Tyagi

Homi Bhabha National Institute (HBNI), Mumbai

Prof. A. K. Tyagi joined the Chemistry Division, BARC Mumbai in 1986. He was the Director, Chemistry Group, BARC. Presently he is a Senior Professor and Dean of HBNI, Mumbai. His research interests are in the field of chemistry of materials, functional materials, nanomaterials, energy materials, metastable materials, hybrid materials and structure-property correlation. He was conferred the prestigious Vigyan Shri in the field of Atomic Energy. He is a fellow of all three science and engineering academies in India and also a Fellow of The World Academy of Sciences.

Nuclear technologies rely on specialized materials which need stringent requirements of chemical and thermodynamical stability as well as isotopic purity criteria. Thus, the growth of nuclear sector is closely dependent on the development of indigenous materials, processes and products, and hence the understanding of basic science plays an important role in development of specific materials and processes for targeted applications. The concepts of chemistry, thermodynamics, processing, crystallography and defects engineering often play important roles toward the development of such materials. This presentation is intended to showcase some of research activities at Chemistry Group, BARC carried out towards nuclear applications. Several examples of development of materials for nuclear back-end and front-end will be discussed. Nuclear safety is another crucial area where substantial research has been conducted. Efforts towards the development of several important products will also be covered. A few examples of tailored materials for possible application in nuclear extreme will also be discussed. This presentation will be mainly focused to highlight the role of underlying science behind these process, materials and products.

Relativistic electron acceleration with mJ lasers at Multi kHz repetition rates

Prof. M Krishnamurthy

Tata Institute of Fundamental Research (TIFR), Hyderabad

Prof. M Krishnamurthy is the Centre Director TIFR Hyderabad and Professor at TIFR. He has been working on experiments related to atomic, molecular and plasma science using intense ultra-short laser fields for more than 20 years. Recently he was instrumental in setting up new laser laboratories and an Extreme Photonics Innovation Center (EPIC) at the TIFR Hyderabad. He is a fellow of the Indian Academy of Sciences and the Indian National Science Academy.

Intense ultrashort pulse lasers generate relativistic electrons when the intensity reaches relativistic scales, 1018Wcm-2 for 800nm pulses. This requires Terra watt class lasers that are complex, cumbersome, expensive and deliver typically 10 pulses per second. While the electron/x-rays/proton beams generated from such system have shown a lot of promise, developing applications on such systems is very challenging. I will talk about experiments where even at a 1/100th of laser intensity, it is feasible to generate relativistic electron beam of 1 MeV energy with multi kHz few mJ/pulse lasers. We show that plasma wave instabilities generated and manipulated with suitable targetry is the underlying mechanism. The source size of the short pulse electron beam is amenable for x-ray radiography and shadowgraphy.

Imprints of Early Adversity - how the brain and body keep score

Prof. Vidita Vaidya

Tata Institute of Fundamental Research (TIFR), Mumbai

Prof. Vidita Vaidya is an eminent Indian neuroscientist and Professor at the Tata Institute of Fundamental Research, Mumbai. Her primary areas of research are neuroscience and molecular psychiatry. She was awarded the National Bio-scientist Award in 2012, the prestigious Shanti Swarup Bhatnagar Prize in 2015 in the medical sciences category and is a Fellow of the Indian National Science Academy, National Academy of Sciences, India and the Indian Academy of Sciences. She has received the J.C. Bose Fellowship from SERB, Govt. of India in 2021 and the Infosys Prize in Life-Sciences in 2022.

Early adversity has a major impact on brain development and later cognitive functioning. It is also a common risk factor for neuropsychiatric and neurodegenerative disorders. Environment leaves its imprints on the body and brain at a molecular, epigenetic, cellular, circuit and behavioural level. Understanding these imprints provides tools on how to ameliorate or reverse some of the scars of early trauma. In my talk I will discuss ongoing research in my group at TIFR that addresses these questions from a neuroscience perspective.

Recent developments in quantum technologies

Prof. Aditi Sen De

Harish-Chandra Research Institute (HRI), Prayagraj (Allahabad)

Prof. Aditi Sen De is an Indian scientist, and a professor in quantum information and computation group at the Harish-Chandra Research Institute, Prayagraj. She is known for her research on quantum information and computation, quantum communication including quantum cryptography, quantum optics and many-body physics. She is the first female physicist to be awarded the Shanti Swarup Bhatnagar Prize for Science and Technology for her contributions to physical sciences in 2018. In 2022, she was elected as a member of Indian Academy of Sciences and Indian National Science Academy.

The quantum theory of nature, formalized in the first few decades of the 20th century, contains elements that are fundamentally different from those required in the classical description of nature. Based on the laws of quantum mechanics, several recent discoveries have been reported that can revolutionize how we think about modern technologies. I will talk about such inventions in the field of computation as well as communication and some of our recent results in building measurement-based quantum computers.

Recent Advances in Nuclear Physics Research

Prof. Aradhana Shrivastava

Bhabha Atomic Research Centre (BARC), Mumbai

Prof. A Shrivastava is Head, Nuclear Reaction Section of Nuclear Physics Division BARC. Her interests are broadly in the area of studying reaction dynamics with stable and weakly bound nuclei, shell effects in fusion-fission reaction and neutrino less double beta decay. She was member of the drafting group for Mega-Science Vision 2035 document, written on initiative by the Office of the Principal Scientific Advisor to the Government of India. She has recently been elected as a Fellow of the National Academy of Sciences, India (NASI).

Nuclear physics focuses on the fundamental problems related to the nature of strongly interacting matter in the universe, starting from its creation. Most of our understanding of the structure of the atomic nucleus has come through the study of low energy nuclear reactions caused by the energetic charged particle accelerators. The present talk will cover recent highlights from the research work done in area of nuclear fusion-fission, nuclear level densities, reactions with weakly bound nuclei etc., utilizing accelerators and neutrino and nuclear structure studies using reactor. Application-oriented programs using accelerators, viz., radioisotopes production, radiation damage studies on space bound devices, yield improvement in wheat and rice seeds, secondary neutron production for cross-section measurements etc. will also be discussed. The future direction in the field and upcoming facilities in India to perform frontline research will be presented.

Spin Entanglement and Quantum Technology

Prof. S M Yusuf

Bhabha Atomic Research Centre, Mumbai

Prof. S M Yusuf is a Distinguished Scientist of the Department of Atomic Energy, and currently he serves as the Director, Physics Group of Bhabha Atomic Research Centre, Mumbai, and senior Professor of Homi Bhabha National Institute. He is an elected fellow of all three national science academies, viz. Indian National Science Academy, the Indian Academy of Sciences, and National Academy of Sciences, India. He is also a J C Bose National Fellow. He has served as Director, the Institute of Physics, Bhubaneswar.

Entanglement is a non-local property of quantum states and it plays a decisive role in quantum information, especially in quantum communication. Entanglement has no classical counterpart. In my talk, I shall introduce the subject of quantum entanglement including the spin entanglement. I shall then present the results of our several recent experiments on quantum entangled spin states. I will also describe the underlying physics that is responsible for novel and exotic spin entangled states. My talk will outline the relevance of such entangled states in quantum technology. The talk will also include the current efforts on quantum technology in BARC in the backdrop of National Quantum Mission (NQM) objectives of Government of India.

Gearing up for Supply of Fuel and Core Materials for Nuclear Power Program for The Next Two Decades

Dr. Komal Kapoor

Nuclear Fuel Complex (NFC), Hyderabad

Dr. Komal Kapoor is the Outstanding Scientist & Chief Executive of Nuclear Fuel Complex (NFC) and the Chairman of NFC Board. He has obtained Doctorate degree in Metallurgical Engineering and Materials Science from the Indian Institute of Technology (IIT), Mumbai. He is an Adjunct Professor in Homi Bhabha National Institute (HBNI), Mumbai and the Guest Faculty at the University of Hyderabad (UoH). His research work has led to the development of several critical nuclear materials which are of great technical importance. He serves on the Boards of Uranium Corporation of India Limited (UCIL) and the Indian Rare Earths Limited (IREL) and the Council Member of Atomic Minerals Directorate (AMD).

With the Country's commitment to decarbonize and move to Net Zero carbon emission, nuclear power is a sustainable option using the proven technologies. With this view, Department of Atomic Energy (DAE) has envisaged several Projects to enhance the nuclear power capacity in the Country. Under this Mission, the fleet mode Reactors have already been launched by NPCIL. The technology of 700MWe Pressurized Heavy Water Reactors (PHWRs) has been demonstrated and two such Reactors became commercially operative. DAE is also considering setting-up of 220 MWe Bharat Small Reactor (BSR) under captive power mode for private industries. With the rapid growth of nuclear power, it is required to plan necessary measures required for operation of these Reactors. NFC has a Mandate to supply the nuclear fuel, reactor components and various other core sub-assemblies.

Rapid expansion is required at NFC to carry forward the DAE Program. Under this, long term planning is done for creation of new facilities and expansion of the existing facilities to meet the reactor requirements.

This paper gives summary of various expansions which are planned in this area. One of the key aspects is to utilize the modern industrial practices and implement automation for increasing the existing capacity. The paper gives an overview of various expansions planned in the next two decades.

Space Efficient Suffix Trees

Prof. Venkatesh Raman

The Institute of Mathematical Sciences (IMSc)

Prof. Venkatesh Raman is an eminent theoretical computer scientist at The Institute of Mathematical Sciences. He is interested in Data Structures and Algorithms. More specifically: Parameterized complexity, Graph Algorithms, Space Efficient Data Structures and Algorithms. He is a Member of ACM India executive council (2016-), Vice President June 2018-June 2020, Secretary June 2020-June 2022, President since July 2022. Member of the ACM-India steering Committees of COMPUTE, Summer/Winter Schools, CS Pathshala.

Suffix trees is a popular data structure to search for pattern strings in a large corpus of text, with applications in Computational Biology and Search engines. Despite its applications, its practical adaptation faced bottlenecks due to its prohibitive use of space for large text. However, recent developments in space efficient data structures (including some contributions from IMSc group) have resulted in practical implementations of suffix trees, particularly in computational biology packages. This talk will describe suffix trees and give an overview of the developments.

Science-Based Development of Plasma & Fusion Technologies

Prof. Shashank Chaturvedi

Institute for Plasma Research (IPR), Gandhinagar

Prof. Shashank Chaturvedi is the Director of the Institute for Plasma Research (HBNI) in Gandhinagar, India. His research focuses on magnetically confined hot plasmas and plasma technologies for industrial applications. He has significantly contributed to India's participation in international fusion energy initiatives, such as the ITER project. He has been involved in promoting plasma-based technologies through the Facilitation Centre for Industrial Plasma Technologies (FCIPT).

Plasma, the fourth state of matter, has properties that are very different from the other three states, viz., solid, liquid and gas. There are three major reasons. Firstly, plasmas are a mixture of free electrons, ions and atoms/molecules; local imbalances in the density of electrons and ions and their velocities leads to the generation of local electromagnetic fields, which in turn affect plasma behaviour. Secondly, unlike the other three states of matter, plasmas can exist over several orders of magnitude in temperature and pressure. Hence the thermodynamic and transport properties of a plasma vary over a wide range. Thirdly, plasma behaviour also depends on the method of production, which sometimes leads to a non-equilibrium plasma. As a result, apart from the well-known application in Nuclear Fusion systems, plasmas lend themselves to a variety of industrial & societal applications, covering areas like waste disposal, industrial tools, textiles, agriculture, medicine/health, defence and space. This talk will present an overview of the Indian programme in developing (a) Nuclear Fusion systems & technologies and (b) Industrial/societal applications of plasmas, as well as the use of high-performance computing for their understanding and optimization.

Science of mineral exploration and mining

Dr. Dheeraj Pande

Director, Atomic Minerals Directorate for Exploration and Research

Dr. Dheeraj Pande is an eminent exploration geologist and the Director of Atomic Minerals Directorate for Exploration and Research (AMD). He was conferred the Department of Atomic Energy Group Achievement Award-2016 in recognition of his immense contribution to the Nuclear Power Programme of India and National Geoscience Award-2019 by the Ministry of Mines.

Science of Mineral Exploration and Mining covers geoscientific aspects of formation, exploration and exploitation of mineral deposits. The status and outcome of sustained exploration activities by the Atomic Minerals Directorate for Exploration and Research (AMD) in augmenting the atomic mineral deposits in India and the follow up activities related to mining and processing of uranium ore by Uranium Corporation of India Limited (UCIL) and Beach Sand Minerals for Thorium, REE, Zr etc. by Indian Rare Earths (India) Limited (IREL) are discussed. The commitment and contributions of the exploration and mining agencies of Department of Atomic Energy (DAE) towards self-sufficiency in atomic mineral resources and clean energy mission of India is highlighted.

Development of quantum technologies using cold atoms

Prof. Satya Ram Mishra

Laser Physics Applications Division, Raja Ramanna Centre for Advanced Technology, Indore, India. Homi Bhabha National Institute, Training School Complex, Anushakti Nagar, Mumbai, India.

Prof. Satya Ram Mishra is a prominent scientist at the Raja Ramanna Centre for Advanced Technology (RRCAT), Department of Atomic Energy, Government of India. He heads the Laser Physics Applications Division at RRCAT and is known for his work in laser physics, nonlinear optics, and atom optics. His research includes the development of solid-state lasers, dye lasers, and laser atom cooling techniques. Dr. Mishra has also contributed to the study of Bose-Einstein condensation and quantum sensors using cold atoms.

The development of advanced technologies exploiting fundamentals of quantum physics is nowadays a frontier activity in the technology innovations across the world. In this context, the development of cold atoms-based quantum sensors is in progress at RRCAT. In this presentation, the development of a cold atom gravimeter (CAG) at RRCAT for precision measurement of earth's gravitational acceleration will be discussed. A gravimeter such as this has applications in exploration of mineral and oil-fields, in geodesy and geophysics, in detection of underground structures, and in monitoring seismic activity. In addition to the gravimeter, the development of other sensors, such as cold atoms based ultra-high vacuum (UHV) sensor and cold atoms based micro-wave field sensor will also be presented. Along with the development of cold atoms-based quantum sensors, it is also planned to expand the activity to optically trap atoms for their use as quantum qubits. The recent progress in this direction will also be covered in the presentation.

Science with Synchrotron facility

Prof. Tapas Ganguly

Raja Ramanna Centre for Advanced Technology, Indore

Prof. Tapas Ganguly is a prominent scientist at the Raja Ramanna Centre for Advanced Technology (RRCAT) in Indore, India. He heads the Accelerator Physics and Synchrotron Utilization Division (APSUD) at RRCAT. His research focuses on the design and development of synchrotron beamlines, high-resolution X-ray diffraction studies, and the growth of semiconductor materials. He has been with RRCAT since 1996 and has made significant contributions to the field of pulsed laser deposition and semiconductor lasers.

Indus-1 and Indus-2 are the only two synchrotron radiation sources in India today, which are indigenously developed and are operating in round the clock mode as a national facility since 2010. Indus-1 is a 450 MeV, 125 mA machine and Indus-2 is a 2.5 GeV, 200 mA machine. There are 19 operational beamlines on Indus-2 and 7 on Indus-1. Indus-2 machine is operated for more than 5500 hours annually and Indus-1 is operated for more than 6500 hours annually. More than 1000 user experiments are carried out annually at Indus beamlines. Over the years, scientists/researchers/students from more than 140 universities, national institutes and research labs from all over the country, have been regularly carrying out experiments at Indus beamlines. More recently, researchers from the R&D sector of Indian industry have also been regularly coming for carrying out experiments at Indus beamlines. The talk will cover the details of the important facilities available at the Indus beamlines and highlight some of the interesting results obtained from the experiments at Indus beamlines.

Why do we need to worry about Gender inequality in sciences?

Prof. Vandana Nanal

Tata Institute of Fundamental Research (TIFR), Mumbai

Prof. Vandana Nanal (TIFR) is a Senior Professor at the Tata Institute of Fundamental Research (TIFR) in Mumbai. She is the Joint Chair of the BARC-TIFR Pelletron Linac Facility (PLF). Her research interests span particle physics and physics beyond the standard model. Prof. Nanal has made significant contributions to the field, including her work on nuclear and atomic physics. She is the Chair of the Gender in Physics Working Group of Indian Physics Association.

The gender inequality in science has been globally recognised as a serious problem, which limits our enterprise from achieving its full potential. The gender gap in the physics profession in India, as elsewhere, is particularly large. Although a few individual women have always been working in physics in India from the pre-independence era, the awareness of gender-based impediments for women physicists is of more recent origin. The root causes of the gender gap in the Physics profession in the Indian context are clearly complex, and need to be addressed both in the local and global context. This talk aims to present a brief overview of the current status, problems, challenges in the Indian context and suggested measures towards achieving Gender Equity.

Nuclear Power and Fast Reactor Program

Prof. B. Venkatraman

Former Director, Indira Gandhi Centre for Atomic Research (IGCAR)

Prof. B Venkatraman is the Director of the Indira Gandhi Centre of Atomic Research. He is an eminent physicist who has combined the physics of Non-Destructive Evaluation with engineering and technology and consistently provided excellent research and development support and robust NDE-based solutions to technologically challenging problems in the nuclear and other strategic and core industries. He is the recipient of the DAE Homi Bhabha Science and Technology Award in 2007.

India is pursuing a three-stage, self-reliant and indigenous nuclear power programme, linking the fuel cycles of Pressurised Heavy Water Reactors (PHWR), Sodium Cooled Fast Reactors (SFR) and self-sustaining 232Th–233U reactor systems Fast reactors form the centre stage of the nuclear power programme for long term energy security and also for the judicious utilization of modest uranium and vast thorium resources. Fast Rectors offer great advantage in terms of fuel efficiency and nuclear waste reduction. A fast breeder test reactor (FBTR) with uranium plutonium carbide fuel core has been in operation since October 1985. The reactor has operated successfully at its rated power of 40 MWth for more than 200 Effective Full Power Days (EFPD) producing more than 50 MU of electricity. The experience and expertise gained in FBTR is being utilised for the Prototype Fast Breeder Reactor (PFBR) of 500 MW(e) which is now an advancaed stage of integrated commissioning at Kalpakkam. India has embarked on a closed fuel cycle. Towards this, a well-structured fast reactor reprocessing development program ihas been established, starting with a pilot facility called the Compact Reprocessing of Advanced fuels in Lead mini cells (CORAL) which is operating since 2003. This facility has served as a test bed to develop the process, equipment and systems and also understand the nuances of the reprocessing of high plutonium mixed carbide fuel. With the experiences gained, an industrial scale Demonstration Fast Reactor Fuel Reprocessing Plant (DFRP) has been successfully commissioned and dedicated to the nation. DFRP would reprocess FBTR spent fuel and is also capable of reprocessing PFBR spent fuel on a campaign basis. DFRP would be the test bed for the first of its kind equipments for large scale commercial fast reactor fuel processing plant which is underway as part of the Fast Reactor Fuel Cycle Facility (FRFCF) being built at Kalpakkam, India. Successful fast reactor program requires a holistic and multidisciplinary approach encompassing design, materials development, and characterization, post irradiation examination, sodium electronics and instrumentation, sodium safety, reprocessing and robust QA for the entire fuel cycle. This talk would provide an overview of the fast reactor program nationally and internationally.

Nuclear Power: Present and Future

Dr. V Rajesh

Nuclear Power Corporation of India (NPCIL), Mumbai

Dr. Veeraraghavan Rajesh is the Director (Technical) at the Nuclear Power Corporation of India Limited. He has worked on several projects such as Kaiga, Tarapur Atomic Power Project and Kudankulam Nuclear Power Project. He is a Member of the Board of Management of Heavy Water Board, Member of the Board of Management of Nuclear Fuel Complex.

As part of clean & green vision, energy transition and energy security have been highlighted as one of the Priority areas. In India's journey towards Viksit Bharat (developed nation), the Nuclear Energy is expected to form a very significant part of the energy mix. The total nuclear electricity generation is going up from 8.1 GWe to about 22 GWe by 2031-32 and further being scaled up to 100GWe by 2047. India aims to have large percentage of its electricity from nuclear sources by prioritizing energy sources. The much-talked low-carbon energy especially nuclear provides strength to India's overall energy transformation strategy (affordable and clean Energy for all) further. To achieve net-zero emissions, identification of energy mix is required.

Neutrino Tomography of Earth

Dr. Sanjib Kumar Agarwalla

Institute of Physics, Bhubaneswar

Dr. Sanjib Kumar Agarwalla is an internationally prominent and well-recognized expert in neutrino physics. He is a Swarna Jayanti Fellow of the Department of Science and Technology (DST), Govt. of India; a Simons Associate of the International Centre of Theoretical Physics (ICTP), and the winner of the prestigious B. M. Birla Science Prize in Physics, 2018.

Neutrinos produced in cosmic ray interactions in the atmosphere provide a unique and independent probe to explore the internal structure and composition of the deep Earth, which is complementary to traditional seismic and gravitational measurements and would pave the way for multi-messenger tomography of Earth. I will discuss the two different approaches to perform Earth tomography with neutrinos: (i) neutrino absorption tomography, based on partial absorption of a high-energy TeV-PeV neutrino flux as it propagates through Earth and (ii) neutrino oscillation tomography, based on Earth matter effects due to the coherent forward scattering of multi-GeV neutrinos with the ambient electrons modifying neutrino oscillation patterns.

Signatures of Non-Trivial Doublon Formation Using a Quantum Computer

Dr. Tapan Mishra

National Institute of Science Education and Research, Bhubaneswar

Dr. Tapan Mishra is associated with the School of Physical Sciences, NISER. His primary area of research is in the field of quantum condensed matter physics in general which broadly focuses on quantum simulations, quantum computing, topological phases of matter, localization transitions, non-Hermitian physics and non-equilibrium dynamics. Dr. Mishra has made several significant contributions to the field and has been awarded the SERB-STAR award for the year 2023.

Doublons are onsite repulsively bound pairs of particles formed due to the interparticle interactions on a periodic lattice. Formation of such doublons from particles initially located on two non-local sites is forbidden if the onsite interparticle interaction is very strong. However, we propose a route to the formation of such non-trivial doublons on a one-dimensional lattice through suitable manipulation of the interactions among the particles. In this talk we will discuss the mechanism of such non-trivial doublon formation and show how their signatures can be captured using a noisy intermediate-scale quantum (NISQ) device.

First results with India's Nuclear Astrophysics Accelerator: FRENA

Dr. Akashrup Banerjee

Nuclear Physics Division, Saha Institute of Nuclear Physics

Dr. Akashrup Banerjee is an Associate Professor at Saha Institute of Nuclear Physics Nuclear Physics Division Centre (Facility for Research in Experimental Nuclear Astrophysics). His research interests include nuclear instrumentation, nuclear astrophysics, and nuclear structure physics. He has received several awards, including the RSE Saltire International Collaboration Award and the SERB-SRG grant. He has also held post-doctoral fellowships at prestigious institutions like GSI, Germany and FRIB, USA.

FRENA is the country's first experimental nuclear astrophysics centre, with a 3 MV Tandetron at its heart. The accelerator is capable of delivering high current beams of low-energy ions. This is ideally suitable for performing studies which will help us in obtaining a better understanding about the origin of our universe. FRENA has been designed in a way, such that various stellar scenarios can be reproduced. Nuclear reaction cross-sections relevant to astrophysical sites can be precisely measured by means of gamma spectroscopy techniques or by detecting neutrons. Recently, a series of experiments have been performed at FRENA which has enabled the calibration of the accelerator terminal voltage. This talk will discuss the FRENA design, recent results as well as the future scope where the national pool of experimentalists can contribute in a critical way.

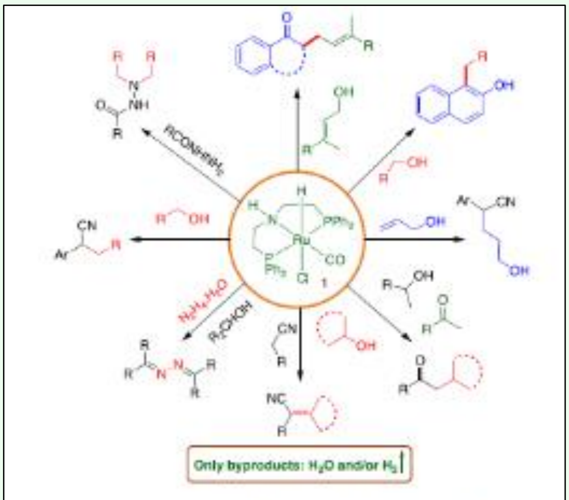
Sustainable Catalysis Enabled by Metal-Ligand Cooperation

Prof. Chidambaram Gunanathan

National Institute of Science Education and Research, Bhubaneswar

Prof. C Gunanathan is a Professor at the School of Chemical Sciences at the National Institute of Science Education and Research, Bhubaneswar. He is a recipient of the prestigious Ramanujan Fellowship from DST-SERB, New Delhi. He won the first prize in the Evonic research proposal competition in 2016. He received the top peer reviewer award from Publons in 2019. In 2020, he received the bronze medal of the Chemical Research Society of India and the Thieme Chemistry Journals award. His research interests include the catalytic applications of pincer complexes for sustainable development and the development of atom-economical hydroelementation processes. He became INSA Associate Fellow in the year 2024.

Construction of C-C and C-N bonds are important reactions in organic synthesis. Catalytic alkylation using alcohol as an alkylation reagent is a green alternative to the conventional alkylation reactions involving alkyl halides and stoichiometric reagents. Employing Ru-macho pincer catalyst which operates via amine-amide metal-ligand cooperation, simple and atomeconomical direct alkylation of nitriles was attained. We have also discovered the catalytic cross-coupling of secondary alcohols. α-Alkylation and α-prenylation of ketones using secondary alcohols and prenol, respectively, were reported. αAlkylation of β-naphthols using primary alcohols was reported recently. Catalytic formal conjugate addition of nitriles with allylic alcohols was developed. Using secondary alcohols, αalkenylation of nitriles and synthesis of ketazine were also reported. Remarkably, water and liberated molecular hydrogen are the only byproducts in these reactions making these catalytic transformations environmentally benign.



Scheme 1. Green catalysis by Ru-MACHO catalyst.

Genetically Engineered Bacteria Identify Prime Numbers, Vowels, and Answer Math Questions

Dr. Sangram Bagh

Saha Institute of Nuclear Physics (SINP), Kolkata

Dr. Sangram Bagh is an Associate Professor at the Saha Institute of Nuclear Physics (SINP), Department of Atomic Energy. He is a part of the Biophysics and Structural Genomics Division at SINP. Dr. Bagh is also a Fellow of the Royal Society of Chemistry (FRSC) in the UK. His research includes Neural cell engineering for building and understanding 'brain-like' neural microcircuits. Building computers and artificial intelligence (AI) with synthetically engineered bacteria. Creating smart therapeutics and novel cellular sensors with synthetic genetic circuits.

Performing cellular computations with engineered bacteria has enormous importance in biocomputer technology development at the micron scale, where microprocessor-based computers have limitations due to energy, cost and technological constraints. Here, we designed and built artificial neural networks with genetically engineered bacteria that can identify prime numbers, vowels, and even determine the maximum number of pieces of pizza or pie that can be obtained from a given number of straight cuts. In addition, the genetically modified bacteria are able to answer mathematical questions such as whether a number n's factorial is divisible by $n \times (n + 1)/2$ OR whether a number n's square can be expressed as the sum of three factorials. All those problems are classic abstract computational problems and are solved by a computer by writing codes in Python or C. Introducing such abstract computational capability in living cells, will be a step forward in biocomputer technology development and may help understanding the biochemical nature of ‘intelligence’.

Radioactive Ion Beams - covering the spectrum from Cosmos to Hadron Therapy

Prof. Vaishali Naik

Variable Energy Cyclotron Centre, Kolkata

Prof. Vaishali Naik is an Outstanding Scientist at the Variable Energy Cyclotron Centre of the Department of Atomic Energy Government of India. She currently heads the physics group and the radioactive ion beam groups at VECC. She has contributed immensely to research in topics related to Radioactive ion beam physics, RIB Accelerator Design, and Radio-frequency quadrupole.

Radioactive Ion Beams (RIB) are new tools that are expanding the study of nuclei in the region away from the line of beta-stability. Gathering nuclear structure data for short-lived nuclei that may play an important role in the rapid-neutron and rapid-proton capture reactions of astrophysical interest is another prime motivation for RIB. Apart from basic research, the technology of RIB accelerators has opened up several potential applications. With RIB, one now has an implantable radio-tracer that can be a probe for depth mapping and can be used even in a chemically incompatible material. A new frontier of hadron therapy may open-up in coming decades, where it may become possible to use RIB for in-situ image guided hadron therapy. Recognising the potential applications in both basic sciences and technology, the department has funded a programme for indigenous development of a RIB facility at VECC. The room temperature cyclotron of VECC is used as the primary accelerator for RIB facility that is currently accelerating ion beams up to 415 keV/u. In my talk, I will present an overview of the RIB facility at VECC that has laid the foundation for the proposed next generation facility called ANURIB - a facility for applied and nuclear research using RIB. The current status of preparation for ANURIB will also be discussed.

Rare Earths: Critical Material for Energy Transition

Dr. B.R Mishra

IREL(India) Limited, Mumbai

The massive deployment of a wide range of clean energy technologies, increasing penetration of renewable energy into the energy supply mix and improvements in energy storage have brought about a significant energy transition and gained rapid momentum. Today, renewable energy has become a powerful and cost-effective source of energy. Energy transition is a transformation of the global energy sector from fossil-based systems of energy production and consumption to renewable energy sources and is made possible by technological advancements and a societal push towards sustainability. REEs have become a material of focus for the energy transition. The deployment of energy technologies such as wind turbines and electric vehicles (EVs) have raised the demand for these key materials. Reducing material intensity and encouraging material substitution via technology innovation can also play major roles in alleviating strains on supply, while also reducing costs. With the pace of energy transitions, supply security of rare earth elements is gaining prominence. Rare Earth elements have played critical role in enhancing the performance of core/functional material. They're vital to catalytic converters, hybrid cars and wind turbines, as well as energy-efficient fluorescent lamps. Permanent magnets are another big role for rare earths. Their light weight and high magnetic strength have made it possible to miniaturize a wide range of electronic parts, including many used in EVs, home appliances, audio/video equipment, computers, military gear to name a few. They also find application in polishing, rechargeable batteries, glass, ceramics, phosphors, pigments, etc. The criticality of rare earth minerals stems from their importance in developing green technologies. Neodymium and praseodymium (LREEs) are key critical materials in the manufacturing of neodymium-iron-boron (NdFeB) magnets. NdFeB magnets have the highest magnetic strength (energy product) among commercially available magnets and enable high energy density and high energy efficiency in energy technologies. Dysprosium and terbium (HREEs) are key critical materials often added to the NdFeB alloy to increase the operating temperature of the magnets. Lanthanum and cerium are used in batteries for hybrid and electric vehicles, while terbium and europium are used in lighting and display technologies. Monazite being the principal source of rare earths in India is known to be radioactive in nature. Less than 0.1% by weight of Monazite is present in beach sand. The mining and extraction processes are quite complex in nature due to assemblage of other minerals like ilmenite, rutile, zircon and sillimanite. Extraction is subjected to grain size, geology, dispersion of deposit and concentration required to have a meaningful deliverable. Mineral separation followed by a specialized chemical process is adopted to produce purified RE compounds by way of eliminating hazardous radioactive material. Separation process needs careful disposal of radioactive waste to produce radioactive free RE products. Moreover, the processed minerals usually take the form of a rare earth oxide (REO), which then needs to be converted into a pure metal before it can be used to make anything. Given REE's omnipresence in technology, IREL has proved its ability in rare earth manufacturing sector for a long time and provided a range of products. Abundant raw material in terms of RE is available with quantities with IREL. In conclusion, rare earth minerals play a critical role in the development of green technologies, and their criticality arises from their scarcity, importance, and geopolitical risks. Mining and production need to be done with expertise to address unwanted disturbance in supply-demand balance due to very low concentration of monazite in the suit of other five minerals. Emerging technologies and disruptive technological innovations through R&D efforts, supplementing the demand and production sides, can enable efficient use of rare earths material and substantial environmental and security benefits. Moreover, continued research and development of alternative materials and technologies for mid-stream and down-stream segments of RE Oxide produced by IREL can be used to establish for further value addition in the country and fill the gaps in transfer of technologies from research to commercial scales. This can help to reduce the reliance on rare earth minerals and ensure the sustainability of green technologies for our Country.

Development of Hydrogen Technologies in BARC

Dr. V Nafees Ahmed

Bhabha Atomic Research Centre (BARC), Mumbai

Dr. V Nafees Ahmed is a Scientist at the Bhabha Atomic Research Centre (BARC), Department of Atomic Energy, Government of India. He is actively involved in the development of hydrogen technologies at BARC. His work focuses on advancing hydrogen production methods, which are crucial for sustainable energy solutions.

India has set its sight on becoming energy independent by 2047 and achieving Net Zero by 2070. Limiting global warming temperatures to 1.5°C requires cutting carbon dioxide (CO_2) emissions by around 37 gigatonnes (Gt) from 2022 levels. Hydrogen stands as a viable solution for reducing greenhouse gas emissions (GHG), if it is produced from non-fossil sources. Today, most of the country's hydrogen supply is grey hydrogen, which is produced using fossil fuels in a process that creates CO_2 gas emissions. Green hydrogen can directly replace fossil fuel derived feedstock in petroleum refining, fertilizer production, steel manufacturing and in mobility sector. BARC is working towards various hydrogen technologies namely Iodine-Sulphur process, and its modified versions, Copper-Chlorine process, Low and high temperature electrolysis, photo catalytic H_2 production, and H_2 storage materials. These technologies have the potential to contribute in achieving Net Zero targets of the country. My talk will focus on these hydrogen technologies that are pursued in BARC and their status.

Heavy Water Technologies and Diversified Activities

Smt. Manisha Rathee

Heavy Water Board (HWB)

Smt. Manisha Rathee is a Scientific Officer – E at the Heavy Water Board, Department of Atomic Energy (DAE).

Heavy Water Board, a constituent Industrial unit under the Department of Atomic Energy has the primary mandate of supporting the three-stage Indian Nuclear Power Programme by production of Heavy Water & speciality materials required in the front end and back end of closed Nuclear Fuel cycle. Today, India is the largest producer of Heavy Water across the globe. HWB is successfully meeting the requirements for Indian NPP and has established itself as a reputed supplier for premium quality Heavy Water in the International market. HWB has successfully developed, demonstrated, optimized and deployed the complex production technology of Heavy Water using H_2S-H_2O Bi-thermal process and NH_3-H_2 Mono-thermal process. Furthermore, HWB has set up production facilities to produce organo-phosphorus solvents, enriched Boron Carbide pellets and Nuclear Grade Sodium to meet DAE's requirements. HWB has also ventured in to development and promotion of non-nuclear applications of HW, Deuterium gas, Oxygen-18, d-labelled compounds and Deuterium Depleted Water to name a few. In the past few years, HWB through its technology demonstration initiatives has taken on its shoulder's recovery of gallium, cobalt, nickel, hydrogen, helium to name a few. The talk will focus on this remarkable journey of HWB in making India self-sufficient in HW production, from the import of HW to its export and further venture of HWB in the various diversification activities.

DAE Centric Keynote

Prof. R Chidambaram

Bhabha Atomic Research Centre (BARC)

Prof. R Chidambaram became the Director of the Bhabha Atomic Research Centre (BARC) in 1990. He was Chairman, Atomic Energy Commission from 1993 to 2000. He was the Principal Scientific Adviser to the Govt. of India and the Chairman of the Scientific Advisory Committee to the Cabinet from 2001 to 2018. He is presently the DAE-Homi Bhabha Professor in BARC. He was awarded the Padma Shri (1975), and the Padma Vibhushan (1999) by the Government of India. He is a Fellow of all the science Academies in India and the World Academy of Science (TWAS), Trieste (Italy). He has been honored with the R.D. Birla Award of the Indian Physics Association, C.V. Raman Birth Centenary Award of the Indian Science Congress Association. He was part of a team of scientists who participated in and supervised India's first nuclear test. He has received D.Sc. degrees (Honoris Causa) by more than twenty universities in India and abroad.

Atomic Energy and way forward

Dr. A K Nayak

Nuclear Controls and Planning Wing (NCPW)

Dr. A K Nayak is the Head of the Nuclear Controls and Planning Wing of India's Department of Atomic Energy. He has received several awards and is a Fellow of Maharashtra Academy of Science and Indian National Academy of Engineering.

EEF1A2 Drives Dual- Mode Angiogenesis in Breast Cancer in Normoxia and via a HIF1A-Driven Feedback Loop in Hypoxia

Dr. Manjusha Dixit

National Institute of Science Education and Research, Bhubaneswar

Dr. Manjusha Dixit is an Associate professor at NISER Bhubaneswar. Her research interest is to understand the genetics and molecular biology of various human genetic diseases, especially cancer.

EEF1A2 is an oncogene associated with various solid tumors. In breast cancer, we identified that it promotes epithelial-mesenchymal transition in both ER/PR-positive and triple-negative breast cancers (TNBCs), with a more aggressive effect in TNBCs. Recently, we identified a novel role of EEF1A2 in angiogenesis. We found that elevated EEF1A2 levels in breast cancer cells promoted enhanced cell growth, migration, and tubule formation in HUVECs, confirmed by both ex-vivo and in-vivo assays. This effect could be counteracted by Plitidepsin. EEF1A2 upregulated HIF1A expression under normoxic conditions through ERK-Myc and mTOR signaling in TNBC and ER/PR positive cells, respectively. Hypoxia further induced EEF1A2, establishing a positive feedback loop with HIF1A. Luciferase assays and EMSA revealed HIF1A binding to the EEF1A2 promoter, enhancing its transcription. RT-PCR and polysome profiling validated EEF1A2's positive impact on VEGF transcription and translation, leading to increased VEGF secretion from breast cancer cells, which activated ERK and PI3K-AKT signaling in endothelial cells. Higher EEF1A2 levels in breast cancer tissues corresponded with increased microvessel density. Overall, EEF1A2 demonstrates significant angiogenic potential in both normoxic and hypoxic conditions, indicating its dual role in promoting EMT and angiogenesis, and suggesting its potential as a target for cancer therapy.

Radiation Damage Studies at Materials Science Group

Prof. Sandip Dhara

Materials Science Group, Indira Gandhi Centre for Atomic Research, Kalpakkam

Prof. Sandip Dhara is a Scientist at the Indira Gandhi Centre for Atomic Research (IGCAR) in Kalpakkam, India. He heads the Surface and Nanoscience Division within the Materials Science Group at IGCAR. His research focuses on nanomaterials, nano-optics, and light-matter interactions. He has made significant contributions to the field, including the development of nanostructured materials for sensors and photocatalytic applications. He is also a Senior Professor at the Homi Bhabha National Institute (HBNI).

Defects and damage studies in materials are an important core activity of Materials Science Group (MSG). 1.7 MV Tandetron accelerator is being effectively utilized to study the radiation effects in reactor materials using heavy ions, giving the defect production rate of up to five orders of magnitude higher than reactor irradiation effects, providing a test bed for simulating the condition of both thermal and fast reactor. The irradiation damage studies in D9 (titanium-modified, 316 stainless steel) alloys have given crucial insight into the importance of Ti to C ratio on the void swelling behaviour. Oxide dispersion strengthened (ODS) steels are the candidate material for future fast and fission reactors due to their better radiation resistance. The Density Functional Theory (DFT) simulations along with Transmission Electron Microscopy (TEM) and Positron Annihilation Spectroscopy (PAS) have shown that in comparison to Al, Zr containing ODS steels give rise to finer distribution of particles along with high number densities and the onset of the defect production is also at higher dose of 150 dpa as compared to the corresponding dose of 100 dpa for Al containing ODS steels. Nanocrystalline Ni, which is a coating material for molten salt reactor upon irradiation with 14 MeV Ni ions, shows that void-denuded zone at the surface is absent. The interaction of O solute with defects and the effect of grain size in FeCr alloy is studied using ionchannelling, high-resolution Rutherford back-scattering (HRBS) and DFT. RBS and Channeling are done to study the irradiation-induced recovery of defects in 3C-SiC. The defects produced by 200 keV Si ions were found to be annealed by irradiating 14 MeV Si ions. PAS has been used extensively to study vacancy defects, voids and their evolution with annealing temperature in Indian reduced activation ferritic martensitic (INRAFM) steels for both fission and fusion reactor applications and high entropy alloys. Besides providing the comprehension of the experimental results, the computational activity at MSG plays a key role in understating defects energetics and calculation of binding energies in bcc Fe, bcc U and U3Si2 using DFT. The random network structures of glass are modelled using ab-initio Molecular Dynamics (MD) and Monte Carlo methods for IPG envisaged as powerful tools for the studies on the retention and stability of IPG after insertion of Cs and Pu for waste immobilization applications. The displacement cascades are studied in Y2Ti2O7, Y2Ti2O5 and Gd2Zr2O7 to understand the basic processes in defect production using MD simulations. MSG equipped with a dual ion beam facility (400 kV ion accelerator for He ions and 1.7 MV Tandetron accelerator for heavy metal ion irradiation) for simulating nearly the radiation damage conditions in the reactor and powerful characterization tools, including PAS (variable low energy DC beam and upcoming pulsed beam of positrons), HRBS/ Channeling, SEM, TEM along with the computational modeling would contribute significantly in providing greater insights to devise strategies for defects studies in the materials of interest for current and future reactors.

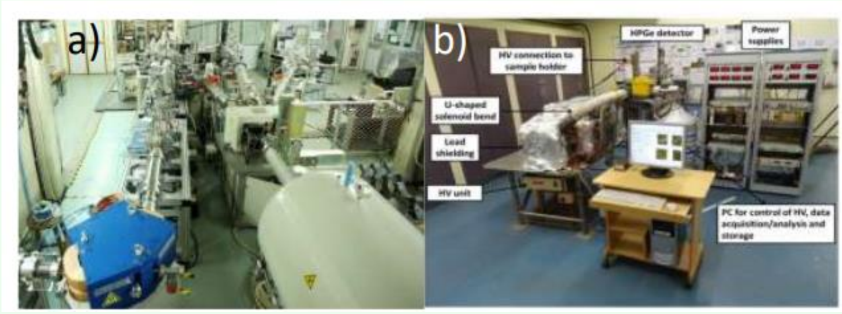


Fig. 1 a) Ion irradiation and characterization facilities b) Positron Annihilation Spectroscopy (PAS) setup

A-Kinase anchoring Protein scaffolds: changing partners for different roles

Prof. Jacinta S. D'Souza*, Amruta A. Shendge, Raza Ali Jafri, Sneha Desai

UM-DAE, Kalina campus, Santacruz (E), Mumbai

Prof. Jacinta S D'Souza is a Professor at the UM-DAE Centre for Excellence in Basic Sciences (CEBS) in Mumbai, India. She is part of the School of Biological Sciences and her research focuses on protein-protein interactions, ciliary biology, and stress biology in the unicellular green alga Chlamydomonas reinhardtii. She has made significant contributions to understanding programmed cell death pathways and the biotechnological applications of marine enzymes.

To find the role of signalling proteins in cellular motility, we have identified four nonconventional AKAPs and two RII-like proteins in four different projections of the central pair apparatus of *Chlamydomonas* cilia. DPY-30 in C1a binds to PF16 and Myc-Binding Protein-1 orthologue (Flagellar Associated Protein 174, FAP174) in C2a, C1b, and C1d-e-f projections binds respectively to FAP65, CPC1 and FAP297. The non-conventional partners are currently being investigated for key features to understand the functioning of these signalosomes. The dimerization domain (aa 1-22) of FAP174 interacts with both the amphipathic helices of FAP65, an A-Kinase anchoring protein. The first 4 ASH domains of FAP65 interact with tubulin, probably a substrate for anchorage. FAP147, an orthologue of Myc-Binding Protein Associated Protein also binds to the C-terminus of FAP174. FAP147, although not a canonical protein kinase, exhibits PKA-like activity. Interestingly, FAP174 also binds to cAMP. This ternary complex is a mimic of the typical AKAP scaffolds that are spread across eukaryotic cells and carry out cAMP-based signalling. In the C1b complex, FAP174 binds to another AKAP, viz. CPC1 (central pair complex 1) with an adenylate kinase domain. CPC1, in turn, binds to Adenylate kinase, FAP42 with an ADK activity, making this projection a hub of ATP homeostasis.

On a complex sequence of vanishing moments

Dr. Manas Ranjan Sahoo

National Institute of Science Education and Research, Bhubaneswar

Dr. Manas Ranjan Sahoo completed his Ph.D. from TIFR CAM-Bangalore and did his Postdoctoral research at the University of Innsbruck (Austria) with an Ernst-Mach stipend. His research area is Partial Differential Equations, particularly conservation laws and delta waves. He has been selected for the Inspire Faculty award in 2015 and INSA Associates in 2024.

In this talk, we show that the vanishing of all moments of the complex sequence {zj} implies that {zj} is identically zero, provided {zj} is in lp, 1≤ p < ∞. This proof is different from one given by Priestley [Proc. Amer. Math. Soc. 116 (1992) 437-- 444]. This shows an interesting connection of this problem with heat-type kernels. Keywords: moments, heat-type kernels, Hermite polynomials References: [1] Andrew Lenard, A nonzero complex sequence with vanishing power sums, Proc. Amer. Math. Soc., 108 (1990) 951–953. [2] W. M. Priestley, Complex sequences whose “moments” all vanish, Proc. Amer. Math. Soc., 116 (1992) 437–444. [3] Sahoo, Manas R.; Satyanarayana, Engu; Sen, Abhrojyoti On a complex sequence of vanishing moments. J. Ramanujan Math. Soc. 34 (2019), no. 2, 185–190.

BIOLOGY

Abstract No: A-1

Differential Effects of Voluntary Physical Exercise on Hippocampal Physiology in C57Bl/6N-derived Mouse Sub strains

Aastha Singla [1,♠], Pratik Chaudhari[1], Maithily Hingmire[1], Darshana Kapri[1], Shital Suryavanshi[1], Sashaina E Fanibunda[1,2], P Govindaraj[3], Rama A Vaidya[2], Ullas Kolthur-Seetharam[1,3], Vidita A Vaidya[1]

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Abstract:

Physical exercise exerts several beneficial effects on the brain, but mouse strains of divergent origins are known to exhibit differential responses to physical exercise. Here compared responses to voluntary physical exercise in two mouse substrains of common origin: C57BL/6NCrl (NCrl) and C57BL/6NCrlCri (NCrlCri). In response to seven days of voluntary wheel running, we observed a robust increase in the BDNF levels, adult neurogenesis, lactate levels, and mitochondrial biogenesis in the hippocampus of NCrl mice, but these effects were highly attenuated in the NCrlCri mice. Upon whole genome sequencing, we observed potentially deleterious single nucleotide variations (SNVs) in ~313 coding genes in the NCrlCri mice that have been inbred for ~165 generations hitherto. Gene ontology analysis showed significantly enriched distinct biological pathways in the gene set harbouring potentially damaging SNVs in the NCrlCri mice, which could shed light on the molecular mechanisms governing the hippocampal effects of voluntary physical exercise.

Abstract No: A-2

Managing Tomorrows waste: Innovation in Urban Waste Management Technologies "Solid Waste Management facilities in Anushaktinagar-Striving towards Zero Waste"

Ar. Anjali Ravikant Karda♠, Shri K.Mahapatra, Shri A.S.Yadav, Shri Rajiv Nayan, Shri Anshu Gupta, Shri P. Salunke

Directorate of Construction, Services and Estate Management (DCS & EM)

Abstract:

In order to comply with the Solid Waste Management rules 2016 of MCGM as well as to address environmental concerns, DCSEM has initiated installation of in-house waste management facilities for achieving zero solid waste discharge. The cycle includes collection, transportation & processing of dry and wet waste as well as disposal of recyclable dry waste. Presently biodegradable wet garbage generation is to the tune of 7 Tons per day (TPD) out of which 4.2 TPD is treated in compost pits and the balance is treated in a modular biogas plant & Nisargruna technology-based biogas plant of 3 TPD capacity each. Besides, a 50kg/day research-based biogas plant, "SHESHA" has also been installed. An additional biogas plant of 3 TPD capacity will be operational by end of 2024. Manure generated by biogas plant is used for lawns while methane gas is utilized for electricity generation. The non-biodegradable dry waste generated is to the tune of 4 TPD out of which the non-recyclable component of 1.6 TPD is treated in plasma-based incinerator & the balance recyclable waste of 2.4 TPD is sent to authorized recyclers.

Thus, while the total solid waste generation in colony is 11TPD, DCSEM has a processing capacity of 6.05 TPD of biogas plant,4.2 TPD of composting and 2.5 TPD capacity of incinerator. Additional 7.5 TPD garden waste is handled by storing, shredding and using it as manure for lawns. This comprehensive approach underscores DCSEM's unwavering commitment to sustainable waste management practices for moving towards a Zero Waste regime.

Abstract No: A-3

The Impact of Altered Peripheral Clock and Gut Dysbiosis on NAFLD

Arka Jyoti De[1,3,♠], Bibek Upadhyaya[2], Palok Aich[1,3]

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Abstract:

Non-alcoholic fatty liver disease (NAFLD) is a multi-system disease associated with the liver. It encompasses a diverse range of histological abnormalities, spanning from basic accumulation of fat (steatosis) to the more severe condition of non-alcoholic steatohepatitis (NASH), which may or may not be followed by fibrosis. Even though there are plenty of literature on the implications and pathophysiology of the disease, very little is known about the aetiology of NAFLD.

Recently, some extrahepatic factors like gut microbiome, clock genes (responsible for circadian rhythm) have been linked as causative factors for this disease. Circadian rhythm at a molecular level, possess additional feedback loops along with the core clock genes. Together, they make up an important link between circadian clock and metabolism by influencing the rhythmic expression of thousands of genes throughout the day. Gut microbiome derived metabolites are also known to influence the expression of clock genes and in turn regulate host physiology. Together, this complex interaction is known as "circadian-gut-brain interaction", and any asynchrony in this interaction can alter the host metabolism significantly, hence may aid in the manifestation of NAFLD.

Abstract No: A – 4

Estimation and verification of dose in blood irradiation by two different techniques

Bhaveshwar Yadav♠

Dr. B. Borooah Cancer Institute (BBCI), Guwahati, Assam.

Abstract:

Transfusion-associated graft-versus-host disease (TA-GvHD) is a rare but potentially fatal complication that can occur following blood transfusion. It arises when donor lymphocytes present in transfused blood recognize and attack the recipient's tissues, particularly in individuals with compromised immune systems. To mitigate the risk of TA-GvHD, blood irradiation has emerged as a crucial preventative measure. Irradiation effectively eliminates donor lymphocytes while preserving the blood's therapeutic properties. Blood irradiation can be carried out by exposing the blood bags to gamma radiation wherein dedicated blood irradiators containing radioactive source such as Cesium-137 and Cobalt-60 are used. As an alternative to gamma irradiators, clinical teletherapy units like Linear Accelerators and Telecobalt units can also be utilised for blood irradiation. Prior to adopting this procedure, investigation of the accuracy of the delivered dose should be carried out using appropriate dosimeters. We fabricated a phantom to accommodate and irradiate blood samples in Linac and Telecobalt units. Simulation and Planning were done in CT simulator and Treatment Planning System. Gafchromic films were used to verify the dose distribution across the volume of the blood bags. Blood bags were also irradiated using a commercially available blood irradiator and the results from the two techniques were compared.

Abstract No: A – 5

Novel method to study the kinetics and structural transitions of the fusion pore opened by SNARE chaperones

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Regulated vesicular secretion is essential for cell-to-cell communication, and its disruption can impair human body function and cause disorders of hormonal release, immune response and neurotransmission. SNARE-mediated membrane fusion involves specialized proteins that merge vesicle and target membranes, enabling vesicular cargo release. During secretion, multiple SNARE complexes assemble at the release site, leading to fusion pore formation. A fusion pore is a transient, small opening that forms between a vesicle and a target membrane during membrane fusion. It allows the initial passage of vesicle contents, such as neurotransmitters or hormones, into the extracellular space or another cellular compartment before the membranes fully merge. The pore's dynamics play a critical role in controlling the release and timing of vesicular secretion. In this study, we investigate the roles of SNARE chaperones Munc13-1 and Munc18-1 in rescuing nascent fusion pores from DAG-mediated inhibition using BLM electrophysiology. Our findings reveal that these chaperones differentially regulate both the size and kinetic properties of fusion pores. Munc13-1, in particular, clusters multiple SNARE complexes at the release site to synchronize release events. Overall, our results highlight the direct influence of Munc proteins on fusion pore assembly, suggesting their critical role in controlling quantal size during vesicular secretion.

Abstract No: A – 6

Prevalence and antibiotic resistance pattern of *Escherichia coli* isolated from Paediatric Oncology patients in a tertiary care Cancer Institute from North East India

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Tata Memorial Centre

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Abstract:

Background: Paediatric oncology patients are always at high risk of infections due to their immune compromised status. Stool cultures from these patients frequently shows Escherichia coli. The prevalence of antibiotic resistance of stool culture isolate *Escherichia coli* in these patients is a significant concern and it is very essential to optimize treatment strategies for such infections. Moreover, these patients are frequently prescribed antibiotics for both prevention and treatment of infection.

Objective of the study:

To Determine the prevalence of *Escherichia coli* in paediatric oncology patients and assess the emerging antibiotic resistance trends in these isolates.

Methodology:

An observational study was conducted in the Microbiology Department of our institute. Paediatric stool samples were collected in hospital and processed for both culture &sensitivity and Routine stool examination to screen for parasites and inflammatory cells. Antibiotic sensitivity was done in commercial Automated system, Vitek 2 compact and resistance gene detection was done using lateral flow assay kits (OKNIVIResist-5).

Results and Observations: A total of 325 stool samples were examined from September 2023 to August 2024 and 72% of the culture isolates were *Escherichia coli* and second most common isolates was Klebsiella pneumoniae followed by Enterococcus faecalis. Among the *Escherichia coli* isolated 65% of the isolates were multidrug resistant organisms. The predominant antibiotic -resistant gene detected was OXA-48 types and NDM.

Conclusion:

There is high prevalence of multi drug resistant *Escherichia coli* in stool cultures of paediatric oncology patients. Further research and regular surveillance of stool samples will be instrumental in addressing this health care challenge by measures like implementation of the Institutional Antibiotic stewardship program and other infection control practices.

Keywords: Paediatric oncology, Escherichia coli, Multi drug resistance, OXA-48, NDM

Abstract No: A – 7

Advancing Research Infrastructure and Services: Fostering Fundamental Research and Scientific Innovation at the National Centre for Biological Sciences (NCBS)

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Abstract:

Modern experimental research relies on our ability to build/procure, maintain and operate high end equipment. For deeper mechanistic understanding of biological phenomena, we need high precision analytical equipment and our ability to analyse big data. The National Centre for Biological Sciences (NCBS), Bangalore, part of the Tata Institute for Fundamental Research, is committed to advancing cutting-edge fundamental research across a broad spectrum of biological disciplines. We house an extensive array of state-of-the-art platforms, including advanced microscopy, genomics, proteomics, and genome engineering in various model organisms. These technologies empower researchers to explore innovative solutions to complex biological challenge.

Our facilities serve not only NCBS scientists but also foster interdisciplinary collaborations, supporting both academic and industry-led research across India and internationally. This presentation will showcase the work carried out at our cutting-edge facilities and detail our strategies for maintaining world-class research infrastructure. We will also highlight our efforts in training the next generation of scientists while addressing diverse scientific and technological challenges. The NCBS research facilities are instrumental in pushing the frontiers of biological science, significantly contributing to India's leadership in global scientific discovery.

Abstract No: A-8

Advanced Multicolor Flowcytometry indispensable Technology in diagnosis and monitoring Hematolymphoid neoplasms

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Abstract:

Introduction: Blood cancer is a type of cancer also known as hematolymphoid neoplasm. The flowcytometry (FCM) is an advanced laser based multicolor cell analysis technique used for detecting and measuring the physical and chemical properties of a particular cell population. It plays a vital role in the diagnosis, treatment, and management of blood cancers such as leukemia, lymphoma, and myeloma. Methods: The study was performed during the period of January 2024 - August 2024, on peripheral blood, bone marrow sample, body fluids/FNA, a total of 350 cases, collected in EDTA tubes processed within 24hrs for 12-15 antibody panel using bulk lyse-stain-wash method and acquired on BD-Lyric flowcytometer (3-laser, 12 color, BD Biosciences). Data analysis and statistical analysis was performed using FACSuit (BD Biosciences) software.

Result: Out of 350 cases, diagnostic cases constitute 250 (Acute leukemia, Plasma cell neoplasm & Lymphoma). The remaining 100 cases were of MRD (minimal residual disease) monitoring.

Conclusion: Multicolor flowcytometry is a rapid, cost effective and highly sensitive method for diagnosing various types of blood cancers as well as serve as a best tool to monitor residual disease status. These findings further guide for treatment response and patient outcome.

Abstract No: A-9

Understanding roles of canonical and non-canonical molecular mechanisms in bacterial survival

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Abstract:

Striding over the unfavourable condition is instinctive response of organisms for survival. Single celled bacteria are no exception to this. Research interest of our lab is to decipher how bacteria overcome antibiotic and physiological stress.

Membrane proteins essential to cellular processes are employed by bacteria to adapt to and overcome adverse conditions. We previously have shown (Mishra M. 2019) up regulation of the outer membrane protein TolC in response to antibiotics and acidic stress in *Enterobacter cloacae*. We are currently expanding the study to understand the precise role it plays in acid survival, and its regulation? Further, we are also interested in understanding the topology of inner membrane efflux proteins that play a cryptic role in survival.

Limiting availability of targets results in lowering killing efficiency by antimicrobial drugs. Bacteria resort to this tactic by slowing down the cellular metabolism resulting in persistence. Our prior findings (Singh S. 2017, Patole S. 2022) showed *Klebsiella pneumoniae* isolates to form persistent cells under unfavourable conditions. We further intend to understand how cellular physiology operates in maintaining genetic integrity of the cells during persistence?

For addressing these questions, we resort to microbial, biochemical, microscopy and other analytical techniques as required from time to time.

Abstract No: A-10

Cell-mediated immune regulation during experimental immune-activation and immune-suppression: Implication in designing strategies for future immunotherapy

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Abstract:

Understanding the origin and consequences of altered cellular immune responses is crucial for developing immunotherapies against rising global health threats. Our research entails studying the contribution of several immunoregulatory molecules in controlling immune responses in tumor microenvironment, viral infection, immune-suppression, and inflammation. We study cellular immune responses involving T cells and accessory antigen-presenting cells (APCs, e.g., macrophages). So far, our work elucidates critical aspects of Transient Receptor Potential channels (TRPs) and Toll-like receptor 4 (TLR4) in modulating T cell and macrophage mediated immune responses, Chikungunya viral infection (CHIKV), and experimental immune-suppression. A major focus of our research is to investigate the immune responses and regulations of macrophages during CHIKV infection. Further, we intend to understand how viral infections alter immune regulation in the tumor microenvironment. Moreover, we aim to elucidate the critical aspects of T cell responses during experimental immune-suppression and cancer immunity. In brief, we study immune regulation and effector immune responses during experimental immune-suppression and immune-activation. Such studies will help to identify the critical aspects of immune regulation to augment the knowledge base of cellular immunity towards designing future immuno-therapeutic strategies to control various diseases.

Abstract No: A-11

3D-Printing a Flexible Surface Mould Brachytherapy Flap: Design, Fabrication, and Dosimetric Validation

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Introduction: 3D-printed brachytherapy applicators, commonly designed as solid, rigid devices, conventionally work on assumption of tissue-equivalent scatter. We developed a novel 3D printed Flexible Surface Brachytherapy Applicator and describe its dosimetric validation.

Materials and Methods: The applicator was designed in Autodesk Fusion-360 (V2.0.20256) as a repeating truncated conical mould unit accommodating commercial 6 French catheters, maintaining the channel centre at 5mm and 10mm surface distances on either side. This shape was optimized for good bed adhesion in FDM printing. This design was 3D printed in flexible TPE material (83A shore hardness).

Phantom treatment plans were generated with a Co-60 source in Oncentra V4.6. Dose calculation was performed with conventional TG 43 and inhomogeneity-corrected TG 186 algorithms. Dosimetry was with Radiochromic Film placed at the surface, prescription depths and OAR-significant within a stack of solid water phantom layers. Doses were measured at multiple points within each plane. Doses measured are expressed in the table below:

Conclusion: While 3D-printing brachytherapy applicators holds tremendous potential, conventional TG-43 based dose calculations failed to account for their high material heterogeneity. Hence, heterogeneity correction in dose calculation and subsequent dosimetric validation are a must when using 3D printed Applicators.

	TG43	TG186		Radio Chromic film		
Depth	**Calculated Value (Gy)**	**Calculated Value (Gy)**	**Percentage Variation with TG43**	**Measured Dose: (Gy)**	**Percentage Variation with TG43**	**Percentage Variation with TG186**
Surface	3.78	3.45	-8.64	3.43	-9.16	-0.57
3mm	3.07	3.08	0.55	3.08	0.36	-0.19
5mm	2.75	2.74	-0.24	2.74	-0.46	-0.23
10mm	2.18	2.13	-2.26	2.13	-2.34	-0.08

Abstract No: A-12

Cell biology lab: Understanding of TRP ion channels for better health

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Abstract:

Our lab explored the structure-function and regulation of selected few TRP ion channels, which are polymodal and thermosensitive in nature. These channels are involved in diverse physiological functions, and any changes in their structure and/or regulation due to mutation or other changes (such as a change in lipidome or post-translational modifications) can induce diverse pathophysiological disorders, commonly known as "channelopathies". Our lab mainly explores the presence of these TRP ion channels in the sub-cellular organelles and their regulations. In addition, possible causes for TRP channel-induced pathophysiology at the cellular and molecular levels. We use diverse cellular systems for such characterization. This lab not only uses different probes; but also helps in the characterization of new probes for measuring cellular structure and functions. The detailed understanding aims to develop tools and techniques for better health care and possible remedies for diseases.

Abstract No: A-13

Insights into DNA Repair Mechanisms in Radioresistant Cyanobacterium *Nostoc* PCC 7120

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Abstract:

Cyanobacteria oldest inhabitants on Earth, adapted to harsh environmental conditions by evolving various stress mitigation pathways. Among cyanobacteria, radioresistant *Nostoc* PCC 7120, exhibit notable DNA repair capabilities, re-stitching γ-irradiation damaged genomic DNA within two days of recovery. *In silico* analysis revealed the absence of RecC, full-length RecB and Ku proteins, indicating absence of RecBCD-HR (Homologous Recombination) and NHEJ (Non-Homologous End Joining) pathways.

In the absence of RecBCD pathway, RecF pathway is the likely main DNA repair pathway. Genes of this pathway exhibited differential expression in response to γ-irradiation and recovery. These genes likely operate in tandem and in specific ratios to achieve efficient DNA repair. Functional characterisation of some of the crucial genes has been carried out resulting in us identifying and establishing their role in radiation tolerance of *Nostoc* 7120. These include a full length functional Single stranded DNA binding (SSB) protein, SbcC, SbcD, RecF, RecO and RecR proteins. Some of these were found to be regulated by LexA, which has now been identified as a global stress regulator in *Nostoc*. Other regulators of DNA repair genes were also identified, which were shown to play a role in regulating DNA repair genes for the first time.

Abstract No: A-14

Fluorimetry-based Heparin and Albumin Detection Instruments: Innovative Solutions for Clinical Diagnostics

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Abstract:

We present two compact fluorescence-based instruments designed for the sensitive and selective detection of Heparin and Albumin, essential biomarkers in anticoagulation therapy and kidney function, respectively. These systems offer rapid and clinically relevant measurements, ideal for both laboratory and point-of-care use. The Heparin Analyzer employs a tetracationic-tetraphenylethylene (TPy-TPE) fluorophore, utilizing aggregation-induced emission (AIE) to enable Heparin detection in aqueous and human serum samples. The system is equipped with a 395 nm LED light source and a photomultiplier tube (PMT), achieving a limit of detection (LOD) of 3 µM with a linear range of 0-170 µM. Results are obtained within 5 minutes, making it ideal for clinical applications requiring timely anticoagulation monitoring. The Albumin Analyzer utilizes a tetraphenylethylene (TPE-1) probe, which selectively detects Albumin in artificial urine matrices. The instrument features a 365 nm LED and a PMT, with an LOD of 0.1 µM and a linear range of 0-1.2 µM. The system delivers results within 1 minute, making it valuable for early-stage kidney disease diagnosis. Both instruments are designed to be compact, efficient, and user-friendly, offering significant potential for improving diagnostic accuracy and patient outcomes.

Abstract No: A-15

Role of Light-Dependent Signalling on Anthocyanin Accumulation in Purple Tomato

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Abstract:

Anthocyanins, a class of water-soluble pigments offer numerous health benefits to humans due to their antioxidant properties. Anthocyanin accumulation is induced by various environmental and developmental signals and regulated transcriptionally by the MYB-bHLH-WD repeat (MBW) complex. Tomatoes are one of the most consumed vegetables worldwide and are rich in essential nutrients and beneficial phytochemicals. However, cultivated tomatoes lack anthocyanin in their fruit but some of its wild relatives produce anthocyanin in the fruit skin in a light-dependent manner. This characteristic has been successfully bred into certain tomato varieties, such as *Aubergine* (*Abg*) tomato accession, which carries a genomic introgression from *Solanum lycopersicoides* and exhibits light-dependent variegated anthocyanin pigmentation in its fruit peel. Previous studies have shown that light-induced HY5 expression promotes anthocyanin accumulation in tomato plants by activating the regulatory gene, *SlAN1*. Additionally, certain transcription factors can respond to light signals independently of HY5 and may either enhance or inhibit anthocyanin production, offering an alternative regulatory pathway. However, the mechanisms by which light controls anthocyanin accumulation in *Abg* tomato varieties remain poorly understood. Our objective is to identify candidate HY5-dependent and independent regulators of anthocyanin biosynthesis under the influence of light in purple tomato fruits through differential gene expression analysis.

Abstract No: A-16

Molecular Pathology Quality Assurance Program (MPQAP) for solid tumor molecular diagnostics

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Introduction: Molecular Pathology Quality Assurance Program (MPQAP) for solid tumors, introduced by Tata Memorial Hospital in 2019, under the aegis of National Cancer Grid, is an External Quality Assurance Scheme (EQAS) designed to ensure uniformity and quality in molecular testing services. This program addresses demand for quality monitoring in routine practise. MPQAP offers testing schemes based on Fluorescence in situ Hybridization (FISH), PCR, Sequencing, and Next generation sequencing (NGS) techniques tailored to the needs of participating centres.

Methodology: Over 5 years, the program expanded from 18 to 50 centres, including 2 international participants. Formalin fixed paraffin embedded (FFPE) tissues were provided as test materials. The performance evaluation is done based on scoring system algorithm developed for preanalytical, analytical and post analytical factors.

Results: Total EQAS cycles (2019-2023) conducted are 46 for various tests. About 251(80%) centres scored >90, 49 scored between 70-90 (15%),10 (3%) scored below 70. Educational webinars were conducted to resolve analytical and post analytical issues leading to improved performance.

Conclusion: MPQAP initiative has become crucial in the era of precision oncology, where MPQAP ensures to support laboratories to provide accurate reliable reports.

Abstract No: A-17

Structure-Function-Dynamics of PL-5 family Proteins and Protein Design

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Abstract:

Our research group is working on structure-function dynamics of Polysaccharide lyases from PL-5 family protein. We aim to deduce the structural basis for the multi-substrate specificity of Smlt1473 and develop a rational protein design approach to engineer monospecific PL-5 proteins to have multi-specificity. The engineered novel enzymes will be advantageous in several applications, including biomass conversion to value-added chemicals. To this end, we have determined the crystal structures of Smlt1473 across pH spectrum in apo (pH 5.0 to 9.0), mannuronate-bound states (pH 5.0 and 7.0), and tetra-hyaluronate-docked structure. Our results suggest that the pH modulates the catalytic microenvironment, and the catalytic tunnel is wide enough for guiding and accommodating structurally and chemically diverse anionic polysaccharide substrates.

Further, our work discovered an alginate-specific endolytic and allosteric polysaccharide lyase PanPL from *Pandoraea apista*. Here, our work demonstrated that the distinct dynamics modes, intrinsic and substrate-induced conformational changes, are vital for the PanPL functioning and allostery. Currently, our efforts are to develop a rational protein design approach to engineer alginate-specific PanPL and AvPL for multiple-substrate specificity.

On the parallel, we are also interested in delineating the principles for oligomerization of transmembrane helical proteins using *de novo* protein design. We have designed a helical segment that inserts into the membrane bilayer, assembles into a helical bundle, and has the desired function.

Abstract No: A-18

Title: Cancer Cells Can Corrupt Their Neighbours

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Abstract:

Cancer has been considered a genetic disease for a long time, and researchers majorly focused on how different gene mutations contribute to cancer progression and disease. Our laboratory focuses on the bidirectional interactions between the cancer cells and the surrounding microenvironment, which eventually determines cancer progression and metastasis. The Tumor-Microenvironment (TME) comprises various stromal cells, such as fibroblasts, endothelial cells, immune cells etc, and the extracellular matrix. Cancer-associated fibroblasts (CAFs) are one of the abundant stromal cells in TME. Currently, we are investigating how tumor cells can corrupt the normal fibroblasts into CAFs and determine their heterogeneity. CAFs are a significant component of the TME in many cancers, including lung, breast and pancreatic cancer. To better understand the disease, we study the key molecules or signalling pathways that maintain the CAF phenotype in the TME. Our laboratory identified that IGFBPs and TGFBI proteins are secreted from CAFs and influence tumor cell proliferation, and drug resistance. We are in the process of identifying other CAF-secreted factors and their impact on tumor cell drug resistance by using systemic approaches. We use co-culture of patient-derived fibroblast and tumor cells, Xenograft and Orthtopic mouse models for lung and pancreatic cancer.

Abstract No: A-19

Unearthing the molecular insights into tropical diseases of plants and animals

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Abstract:

Tropics have been the breeding grounds for most of the insects and disease-causing pathogens. Environmental conditions favor the growth and proliferation of these organisms' causing diseases in plants and animals to an extent resulting in epidemics. Malaria is one of the most serious diseases of humans caused by Apicomplexan pathogens of the genus *Plasmodium* that is responsible for around 4 million deaths every year. At CEBS, we study a wide range of synthetic, semisynthetic, peptide-like and non-peptidyl inhibitors as potential antimalarial drug candidates. Plasmepsins are the key enzymes in the life cycle of malarial parasites and have emerged as novel antimalarial targets. A detailed understanding of the nature of interactions between the drug molecules and amino acid residues of plasmepsins is carried out using biophysical and biochemical techniques. This will provide lead molecules for designing new antimalarial drugs with enhanced efficacy. In another study, an integrative structural biology approach is used to identify potential inhibitors of *Plasmodium* actin regulatory proteins (ARPs), specifically ADF 1, ADF 2, and profilin. In this study, high-throughput screening of a ligand library, molecular docking, and biophysical assays such as fluorescence spectroscopy, circular dichroism, and isothermal titration calorimetry were employed to identify the inhibitor(s) impacting actin dynamics *via* the ARPs. A detailed structural and biophysical study is being performed to gain insights into the ARP-actin interaction in the presence of the inhibitor(s). This in the long run will aid in developing antimalarial drug(s) targeting gliding motility in *Plasmodium*. Disease incidences and disease severity is quite pronounced in crop plants growing especially in the tropical and subtropical regions affecting global food security and loss of biodiversity. Fusarium wilt disease of banana (caused by *Fusarium oxysporum* f. sp. *cubense* (Foc) is one such disease that causes wilting of banana plantations. In order to develop innovative management strategies, it is essential to understand the molecular nitty-gritties of the banana-*Fusarium* interaction. In our study we demonstrated the role of FocSge1 (a transcriptional coactivator) in pigmentation, hydrophobicity, mycelium growth, pathogenicity and conidiogenesis. We have cloned and expressed FocSge1-GST fusion protein in *E. coli* that is currently being used as bait to identify its protein interactors in Foc that can be targeted to develop transgenic banana plants resistant to *Fusarium* wilt.

Abstract No: A-20

Addressing Bottlenecks in Drug Discovery Pipeline for Better Therapeutics

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Abstract:

Rational drug discovery and development require a streamlined collaborative team effort from experts specialized in their domains. Through this multidisciplinary effort, hurdles like off-target effects, polypharmacology, and chemoresistance can be alleviated, subsequently shortening the time required for translating a lead molecule to a potential drug candidate. A pharmacological conundrum starts when synonymous results are not observed within *in-vitro* and *in-vivo* studies, due to several factors like the molecules' differential physicochemical properties, bio-pharmacokinetics, structural mimicry, microenvironments, or chemoresistance. Our lab focuses on some of these caveats by understanding and rationally designing optimal drug delivery systems, novel conjugates, and targetability for effective therapy. We apply different *in silico*, *in vitro*, or *in vivo* approaches like pharmacophore modelling, database curation, transcriptomic analyses, and cell- or animal-based studies to achieve our objectives. Cancer, arthritis, infectious wound healing, macrophage-remodelling are the selected broad domains where we have addressed chemotherapeutic agents' limitations. Through our continued efforts, we successfully identified a least explored phenotype switching (M1 to M2) of naturally-occurring isothiocyanate at sub-lethal dose, whose proof-of-concept was studied in animal models (acute and chronic inflammatory model), further with different nano-formulations (liposomal, thermo-responsive hydrogel, combinational hydrogels) an increased efficacy was achieved in chronic conditions (arthritis). With the experience gained, we intend to extend our work in multimodal therapy further

Abstract No: A-21

Establishing Individualized Bladder Filling Protocol for Delivering IMRT In Radical Chemoradiation of Cervical Malignancies: A Feasibility Study

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Purpose: In intensity modulated radiotherapy, target volume and organ at risk position reproducibility is essential. The aim of this study was to compare reproducibility of an individualized bladder protocol, determined with transabdominal ultrasound scan, to a uniform bladder protocol instruction followed by the institution.

Materials and methods: Patients planned for radical pelvic radiotherapy for cervical cancer, were randomly assigned to follow either the uniform institutional protocol of 500mL water intake and 30 minutes waiting time or to have their protocol instruction as determined by individual transabdominal ultrasound using varying water intake and wait times. The bladder volumes measured by cone beam computed tomography scans and the time required to achieve the desired bladder volume, were recorded and compared between the groups.

Results: 40 out of 42 patients were evaluated. Analysis of variance showed better consistency of bladder volume difference in the personalized protocol (PBP) group as compared to the institutional (IBP) group ($p = 0.003$). The difference between the allotted protocol time and wait time during the treatment days was significantly less in the PBP group (p value = 0.001 - 0.017 across the weeks).

Conclusion: Transabdominal ultrasound-based determination of bladder protocol on planning scan day ensures bladder volume and desired protocol time reproducibility during pelvic radiotherapy.

Abstract No: A-22

A Discovery, Drug-Screening, and Delivery pipeline against Human diseases

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Abstract:
As we age, environmental stressors predispose us to various non-communicable diseases (e.g. cancer). Using molecular epigenetics, Dr. Sen's group dissects how abiotic stressors drive gene silencing to induce disease phenotypes. Using cancer and stem cells, *Bivalent chromatin* and H2A.Z was found to counteract DNA methylation by a ROS-induced collaboration between DNMTs-Polycomb-HDAC pathways: a likely final frontier against cancer-DNA methylation. A conservation of this ROS induced gene silencing was surprisingly discovered in the green algae, *Chlamydomonas*. This conservation was reverse-engineered to develop transgenic libraries that were used to screen epigenetically-active plant extracts. In addition, the screen also identified a novel conservation of Zn induced chromatin compaction that drives gametogenesis, even in humans. Down the pipeline, Dr Lopus's group has made several therapeutically relevant discoveries regarding the efficacy of gold nanoparticles, ayurvedic drug molecules, and the possibility of inducing non-apoptotic cell death in cancer cells. Their findings on the ability of surface-functionalized gold nanoparticles to selectively kill cancer cells via different exciting mechanisms have paved the way for exploring further the therapeutic utility of these nanoparticles. Their subsequent investigations unraveled the ability of ayurvedic phytochemicals-based gold nanoparticles induce such forms of cell death. Inspired by these studies, the group is currently investigating the mechanistic details of these cell deaths as well as exploring the ability of the non-ayurvedic formulations as radiosensitizers and chemosensitizers of cancer cells. The long-term goal is to use the discovery and screening platform as a feeder towards developing novel ayurvedic-inspired drugs and functionalized nanoparticles for targeted delivery, developing indigenous IP.

Abstract No: A-23

Estimation of airborne contamination during therapeutic radioiodine-131 (I-131) administration of capsules and solution form: A comparison study

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Introduction:
In Nuclear medicine radionuclide therapies 90% are performed using with I-131, because of its physical and radioactive properties. I-131 is available in solution and capsule form. The solution form of I-131 is having higher exposure risk, due to vaporization and spillage. The optimal concentration of I-131 in air is defined by Derived Air concentration (DAC). According the radiation safety guidelines for airborne concentration of I-131 mustbe less than 416.7Bq/m^3.
Aim: To compare the airborne contamination during the administration of capsule and solution form of I-131.
Objective:
The objective of this study is to compare the airborne contamination by calculating DAC for all samples during dispensing and administration of I-131by using capsule and solution form.
Materials & Methods:
In this study air monitoring was performed using a portable air sampler with charcoal impregnated cellulose filters measure the I-131 contamination (air) by sample collection and analysis. The measured airborne activity concentration is expressed as a fraction of the DAC limits for I-131.
Results:
Data was collected during I-131 dose administration (50 mCi to 200 mCi) in total of 50 patients. The minimum airborne contamination while dealing with 50mCi of I-131in capsule form i.e. 8.33Bq/m^3 and maximum with 200mCi of I131solution form i.e. 77.40Bq/m^3.
Conclusion:
Use of I-131 in capsule form limits the airborne contamination and spillage, thereby making radioactive waste management easier. Although the maximum values obtained in this study are 6 times and 11.6 times below the standardised DAC limits for solution and capsule forms respectively.

References:
1)Amy Kopisch, Chris B. Martin, and Vesper Grantham. J Nucl Med Technol2011; 39:6062
Key Words: Airborne contamination, I-131solution form, I-131 capsule, Derive air concentration, Radiation safety

Abstract No: A-24

Decoding the Regulatory Network of Cancer Hallmarks through FRG1, IQGAP2, and EEF1A2: Cancer Genomics and Genetics Group Research Overview

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Abstract:

Cancer remains a major global health challenge, with issues like treatment resistance and frequent recurrence driven by complex molecular interactions. Our research group is dedicated to uncovering regulators of cancer's multiple hallmarks, specifically the upstream regulators in the signalling network. We also focus on the role and mechanism of genetic predisposition and dietary factors in Gallbladder cancer.

We discovered that FRG1, originally associated with FSHD, functions as a tumor suppressor in multiple cancer types. It regulates both angiogenesis and cell migration and is part of an intricate network formed by FRG1, IQGAP proteins, and translation elongation factor EEF1A2. FRG1 regulates the transcription of GMCSF and NMD genes and has a dual role in balancing nonsense-mediated decay. Additionally, we found that IQGAP2 inhibits breast cancer progression and tumour angiogenesis by blocking the signalling pathways mediated by the scaffolding protein IQGAP1. This balance between IQGAP1 and IQGAP2 is crucial for cancer development. Furthermore, EEF1A2, which is overexpressed in cancers, regulates EMT and angiogenesis in breast cancer. It interacts with HIF1A in a positive feedback loop and modulates the interaction between IQGAP1 and IQGAP2.

These findings provide new insights into the molecular mechanisms of cancer, offering potential new targets for therapeutic intervention.

Abstract No: A-25

Optimizing reconstitution conditions for MgtE from *Bacillus firmus* in nanodiscs: A comparative study with membrane-mimetics

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Abstract:

Magnesium is a crucial cofactor for various cellular processes such as enzyme activation, nucleic acid stability, and ATP metabolism. In prokaryotes, magnesium homeostasis is regulated by magnesium ion channels, including the **Magnesium transporter E (MgtE)**, conserved amongst different organisms. Its eukaryotic ortholog, **SLC41A1**, is a solute carrier protein, and its dysfunction has been linked to Parkinson's disease and head and neck cancer. We have recently characterized the expression, purification and Mg^{2+} transport function of a novel **MgtE from** *Bacillus firmus* (*$MgtE_{BF}$*). Here, we characterize the reconstitution of $MgtE_{BF}$ into **nanodiscs** that provide a native-like lipid environment for biophysical studies. Nanodiscs are disc-shaped phospholipid bilayer which are stabilized by amphipathic membrane scaffold proteins (MSP). Key factors such as lipid-to-protein ratio, detergent removal, and incubation conditions were optimized to achieve efficient incorporation of the MgtE Mg^{2+} channel into MSP1E3D1 nanodiscs. Using the single native cysteine of $MgtE_{BF}$ that is labelled with the environment-sensitive fluorescent probe **7-nitrobenz-2-oxa-1,3-diazol (NBD)**, we have monitored the functionally significant dynamic changes in nanodiscs and other membrane-mimetics. Furthermore, size-exclusion chromatography and NBD fluorescence of the labelled protein have been used to monitor the successful reconstitution of $MgtE_{BF}$ in nanodiscs. This study provides insights in the standardization of reconstitution conditions of the novel $MgtE_{BF}$ in nanodiscs that can be used to perform structural studies directly in membranes using cryo-EM.

Abstract No: A-26

Amyloid-β Mediated Modulation of TREK1 Ion Channel in Alzheimer's Disease

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Abstract:

Alzheimer's disease (AD) is a neurodegenerative disorder characterized by dementia, cognitive dysfunction, and memory deficits. Amyloid β (Aβ) and tau accumulation contribute to disease progression. We investigated the role of TREK1, a two-pore domain leak potassium channel, in AD pathophysiology. Primary neuron-astrocyte cultures exposed to Aβ oligomers showed increased TREK1 expression, which was decreased when hyperexcitability was blocked. This suggests TREK1 upregulation is a consequence of hyperexcitability. We explored the cyclic AMP-PKA pathway involvement in TREK1 regulation and found that blocking AC1(Adenylate cyclase 1) decreased TREK1 expression. However, PKA blockade did not fully reverse Aβ -induced TREK1 upregulation, indicating additional pathways are involved. Our findings suggest TREK1 is modulated by AD-related hyperexcitability. Further research is needed to elucidate the complex signaling mechanisms regulating TREK1 in AD and how it in turn modulates AD pathophysiology.

Abstract No: A-27

Decoding the complexity of aging disorders through investigation of genetic and epigenetic regulators

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Abstract:

Understanding the diverse genetic and epigenetic regulatory mechanisms is essential for maintaining human health and alleviating disease conditions. Our research explores the complex regulatory landscape underlying age-related changes that perturb the delicate homeostasis between cellular degeneration and proliferation. Employing a multifaceted approach involving cellular, molecular, and omics techniques, our lab investigates genetic and epigenetic factors contributing to the pathogenesis of glaucoma, corneal dystrophies, and cancer.

Over the last two decades, findings from our lab have revealed significant gene and protein dysregulation due to risk variants, altered chromatin interactions, and changes in DNA methylation patterns. The research also identified potential non-invasive biomarkers for disease detection. In addition to elucidating disease mechanisms, our study extends to drug screening to identify possible interventions to alleviate disease symptoms and progression. This holistic approach bridges the gap between basic research and clinical application and lays the groundwork for developing early detection strategies and targeted therapeutic interventions. Key highlights also include the development of a pipeline for screening potential anti-cancer drugs using various *in vivo* glioma models.

Abstract No: A-28

Host membrane sculpting and remodeling by Mycobacteria

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Abstract:

Mycobacteria evades host defence by hijacking phagosome maturation and often rupturing the phagosomal compartment. The escape is facilitated by the secretory components such as membrane vesicles (MVs), virulent proteins as well as direct-physical contact with compartmental membrane, however, the mechanisms remain unknown. We show that MVs spontaneously fuse with the cell membrane and increase their elasticity. Upon internalization MVs significantly delay the kinetics of Rab 5 recruitment resulting in the slowing down of the phagosome maturation. We discover that ESAT-6 undergoes fibrillation and the polymerization forces drive phagosomal vesiculation. Interestingly, MVs slow down the rate of phagosomal vesiculation by decreasing membrane fluidity thus impacting the ESAT-6 mediated deformation. The ESAT-6 mediated deformation is further enhanced by the direct contact of bacteria inside phagosome-like encapsulating compartment that induces lipid wrapping, membrane bending, and lipid phase separation. The degree of phase separation is driven by the surface condensation on the bacterial contact surface. A higher bacterial load reduces the bending rigidity and increases the area stretch modulus. Further, MVs significantly delay the fusion of the phagosome with lysosome and subsequently found to fuse with and increase the viscosity of the endoplasmic reticulum. Interestingly, MVs infection also significantly reduced the number of lipid droplets accompanied by an increase in their size.

Abstract No: A-29

Plant Biology lab: Understanding Plant Development Under Climate Change

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Abstract:

Our lab focuses on plant development and has been instrumental in setting up a state-of-the-art facility at NISER. We explore the fundamentals of light, phytohormone and temperature regulation and its cross-talk that shapes fitness during evolution in model organisms like *Arabidopsis*, Moss, Rice, and Mung bean. Strikingly, we developed nanoparticle based improved plant productivity, an algae based phyto-remediation of hexavalent chromium, an understanding towards Orchid flowering and obtained cold tolerant lines of mung bean (*Vigna radiata*). Moreover, the novel role of plant specific nuclear protein, GIGANTEA (GI) has been implicated in tolerance to various biotic and abiotic stress. Our work also demonstrates an important step towards understanding molecular evolution from bryophytes to higher order angiosperm.

Abstract No: A-30

At a Glance- Cancer and Molecular Signalling Lab, NISER

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Abstract:

Our research focuses on elucidating complex mechanisms involved in cancer pathogenesis. By applying our expertise, we intend to know the effect of hypoxia and *Helicobacter pylori* infection behind gastric cancer (GC) pathogenesis and identify tissue level as well as circulating biomarkers for early detection and therapeutic intervention. Core competencies of our group are in the fields of ubiquitin-proteasome-system, study of extracellular vehicles (EVs), posttranslational modifications, cytoskeletal remodelling, cell adhesion mechanisms, oxidative stress and cancer metastasis. Our research based on *in vitro* studies, animal models and patient tissue and blood samples has identified crucial mechanisms involved in GC cell survival, reactive oxygen species (ROS) generation and cancer metastasis which will be elaborated during the presentation.

Abstract No: A-31

Peptide-mediated signal relay dictates transition of wound responses through rice PSK receptor, OsPSKR

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Abstract:

Wounding is a general stress in plants that results from various pest and pathogenic infections in addition to environment induced mechanical damages. Plants have sophisticated molecular mechanisms to recognize and respond to wounding with monocots being distinct than dicots. Here, we show the involvement of two distinct categories of temporally separated, endogenously derived peptides, namely, plant elicitor peptides (PEPs) and phytosulfokine (PSK), mediating wound responses in rice. These peptides trigger a dynamic signal relay in which a receptor kinase involved in PSK perception named as OsPSKR plays a major role. Perturbation of OsPSKR expression in rice leads to compromised development and constitutive autoimmune phenotypes. OsPSKR regulates transitioning of defense to growth signals upon wounding. OsPSKR displays mutual antagonism with the receptor involved in PEP perception, OsPEPR1. Collectively, our work indicates the presence of a stepwise peptide-mediated signal relay that regulates the transition from defense to growth upon wounding in monocots.

Abstract No: A-32

Venetoclax Triggers Mitochondrial Stress and PML-RARA Degradation to Overcome Arsenic Resistance in Acute Promyelocytic Leukemia

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Abstract:

Acute Promyelocytic Leukemia (APL) is characterized by the presence of PML-RARA oncofusion protein. Arsenic trioxide (ATO) resistance in APL presents a significant challenge in treatment, necessitating alternative therapeutic approaches. Venetoclax, an agent targeting Bcl2, has shown potential in recent case reports to overcome ATO resistance due to its ability to induce apoptosis. This study aimed to assess the efficacy of Venetoclax in overcoming ATO resistance in APL using cellular and animal models of APL. Synergistic effects between ATO and Venetoclax were evaluated through cellular proliferation assays, mitochondrial stress markers, and apoptosis-related proteins. Electron microscopy and JC1 assays revealed increased mitochondrial reactive oxygen species (ROS) and depolarization in resistant cells treated with Venetoclax, either alone or in combination with ATO. Immunoblotting confirmed Venetoclax-induced degradation of PML-RARA in resistant cells, supporting apoptosis induction. In vivo, orthotopic xenografts of ATO-resistant APL showed a marked reduction in tumor burden measured as hCD45+ marrow cells, coupled with increased apoptosis and ROS production following Venetoclax and ATO co-treatment. The tumor volume and weight significantly decreased by Ven-ATO without compromising body weight and showed no toxicity to the vital organs. These findings highlight Venetoclax as a promising therapeutic option for overcoming ATO resistance in APL by promoting mitochondrial stress and PML-RARA degradation.

Abstract No: A-33

Molecular Insights of Polymerisation in Different Plasmid Segregation Systems

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Abstract:

Low-copy-number plasmids contain exclusive specialized segregation systems, such as the ParA Walker-type cytoskeletal ATPases (WACA) and ParM actin-like proteins, for their maintenance. Both systems depend on ATP-driven dimerization for polymerization, but the precise role of ParA polymerization in plasmid segregation is not fully understood. In this study, we investigated the function of the C-terminus of ParA in *Escherichia coli* F plasmid segregation, focusing on two key mutations (Q351H and W362E) that form cytoplasmic filaments independent of the ParBS partitioning complex. Additionally, we explored the dynamics of diverse ParM proteins from different bacterial species using *Schizosaccharomyces pombe* as a heterologous expression system. Remarkably, a single cell of *Clostridium perfringens* harbors 11 plasmids with distinct ParM genes, but their insights of plasmid coexistence are not well explored. Here, we showed the role of filament dynamics of *C. perfringens* ParM in the coexistence of plasmids. Our studies thus revealed how nucleotide-dependent polymerization affects ParA and ParM dynamics, with implications for plasmid maintenance.

Abstract No: A-34

Conformational dynamics of viral molecular machines in viral entry and genome replication

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Abstract:

The ability of a virus to orchestrate complex functions in a cell employing only a few proteins is due to the unique structural features of viral proteins. Cell entry and genome replication are such complex processes that viral protein complexes (‘molecular machines) perform. Enveloped viruses, such as SARS-CoV-2, Chikungunya (CHIKV), and Dengue virus (DENV) use their membrane surface proteins, S-, E1/E2 complex and E, respectively, for binding to a receptor on their host cell. Viral envelope proteins (E) also facilitate viral-cell membrane fusion. E-proteins undergo dramatic conformation changes during membrane fusion. Our interest is to characterize the conformation dynamics in E-proteins using biochemical, MD-simulations and molecular virology approaches. Currently, our focus is on explaining the dynamics of the receptor-binding domain (RBD) of SARS-CoV-2 S-protein. The RBD can be either in the ‘up’ or ‘down’ configuration in the S-trimer, influencing receptor (ACE-2) binding. Earlier studies from our group have characterised the conformation dynamics of the E1/E2 protein complex of CHIKV to explain their mechanism. Ongoing work aims to explain the interaction of the fusion protein with the membrane to ensue membrane fusion. Another focus area for the lab is to understand the dynamic interactions of proteins required for genome replication of Influenza virus and DENV. Earlier work from the lab showed the significance of DENV Nsp3-Nsp4b interaction on the domain dynamics of Ns3 RNA helicase and its helicase activity and viral protease functions. The influenza RNA-dependent-RNA-polymerase’s structural mechanism is another area that we are interested in.

Abstract No: A-35

Understanding how novel selection pressures shape biodiversity and ecosystem sustainability

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Abstract:

Evolutionary Ecology Lab @NISER (EEL@NISER) is dedicated to uncovering the forces and mechanisms that shape the evolutionary paths of organisms. The primary driver of biological evolution, natural selection, influences traits through both biotic and abiotic factors. Biotic interactions—like competition, cooperation, and neutral effects—operate at multiple levels, from individuals to populations, communities, and entire biomes. Modern sequencing techniques reveal that these interactions extend beyond the macroscopic world, significantly influencing microbial communities as well. At the intersection of these worlds, macroscopic hosts and microbes interact, shaping each other's evolutionary journeys. EEL@NISER explores these biotic interactions across various organizational levels, from host communities to individual hosts, host-microbiome interactions, and microbial communities, to understand their impact on host organismal evolution. Recently, rapid changes in both biotic and abiotic selection pressures, driven by anthropogenic factors like urbanization, climate change, and pollution, have posed significant challenges. Organisms' responses to these threats are limited by their genetic and phenotypic plasticity. EEL@NISER investigates how both macro and microscopic organisms and communities adapt to this rapidly changing selection landscape, with the aim of predicting and conserving ecosystem sustainability.

Abstract No: A-36

Complex Yet Fascinating Molecular Mechanism of the Eukaryotic Translation Initiation: Rules and Exceptions

Tanaya Kole♠, Aranyadip Gayen, Ilina Bhattacharya, Binayak Mohapatra, A. Akhil Kumar, Anup Kumar Ram, Advita Sharma, and Pankaj V. Alone*

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Abstract:

The selection of the start codon and establishing an open reading frame is crucial for decoding and translating the genetic code into protein. In *Saccharomyces cerevisiae,* more than 13 translation initiation factors (eIFs), 40S ribosomal subunit, and Met-tRNA$_i^{Met}$ are involved in the selection of the AUG start codon during 5′ to 3′ mRNA scanning. Our lab focuses on various aspects of translation initiation regulation. We investigate how small ribosomal proteins and rRNA contribute to the stringency of start codon selection and biogenesis of small ribosomal subunits. Additionally, we study the intricacies of eIF2-GTP-Met-tRNA$_i^{Met}$ ternary complex (TC) formation and its role in the stringency of the start codon selection. Mutations that compromise the fidelity of translation initiation change the proteome, and adversity affects cellular physiology. We are also exploring the evolution of the GTPase-activating protein eIF5 in the eukaryotes and how it stimulates the GTPase activity in the TC during start codon selection. We investigate how a non-AUG codon can be chosen as a start codon in wild-type cells despite the regulatory mechanisms favouring the AUG codon. We aim to decipher the molecular mechanisms of the mRNA's cis-elements and various trans-acting factors involved in the non-canonical translation initiation process.

Abstract No: A -37

Biogeographic evolution of Tropical Rainforest

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Abstract:

Tropical rainforests (TRF) are the most abundant terrestrial ecosystems that support half of the global plant species, necessitating to understand their origin and evolutionary history. TRF of Southeast Asia are ecologically distinct by having 80% of their emergent trees belonging to plant family Dipterocarpaceae. The present study reports the oldest known fossils of *Dipterocarpus* type pollen from the Maastrichtian of Africa and eight pollen types corresponding to six extant genera of Dipterocarpaceae from the Paleocene-Eocene of India. The paleobiogeographic investigation of morphology of the recovered fossils coupled with the molecular sequences of comparable extant species suggests the origin of Dipterocarpaceae in the seasonally wet regions of tropical Africa during mid-Cretaceous (~102 Ma), and subsequent evolution as an adaptation to seasonal to perhumid climate in the Late-Cretaceous. The family further dispersed to India via Kohistan-Ladakh Island Arc during Maastrichtian-Paleocene leading to the diversification of aseasonal dipterocarps on the Indian Plate. The India-Asia collision promoted the spread of Dipterocarpaceae from India to similar climatic zones in Southeast Asia during Eocene, supporting "Out-of-India" dispersal hypothesis. The family rapidly diversified around 20 Ma in Southeast Asia giving rise to the Southeast Asian TRF. On the other hand, most of the genera disappeared from India owing to the strengthening of the Indian monsoon.

Abstract No: A -38

Cellular trafficking and Nuclear Expansion

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Abstract:

Biomolecules are trafficked and targeted to various compartments after their synthesis. This process plays important role in organelle biogenesis and cellular homeostasis. We have earlier shown the role of cardiolipin in nuclear expansion. In this study we have demonstrated that a specific lipid cargo, cardiolipin is transported from plasma-membrane to nuclear envelope by a direct endocytic route. The pharmacological as well as genetic intervention established that late endosome carries cardiolipin to the nuclear envelope and is important for rapid nuclear expansion. Overall, this study identified a novel endocytic route and established the role of plasma-membrane on regulating nuclear biogenesis.

CHEMISTRY

Abstract No: B-1

Terahertz Conductivity of Free-Standing 3D Covalent Organic Framework Membranes Fabricated via Triple-Layer-Dual Interfacial Approach

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Abstract:

Processable covalent organic framework membranes (COFMs) are emerging as a potential class of semiconducting materials for device applications. Despite extensive exploration of two-dimensional (2D) COFMs, the fabrication of crystalline, self-standing three-dimensional (3D) COFMs poses significant challenges. In this work, we have developed a unique time and solvent-efficient triple-layer-dual interfacial (TLDI) approach for the simultaneous synthesis of two 3D COFMs from a single system by deliberately choosing a system of three immiscible solvents with varying specific gravities. The mechanical robustness of the synthesized 3D COFMs, essential for potential applications, has been assessed using the nanoindentation technique. Besides, for the first time, the optical conductivity of these free-standing 3D COFMs is analyzed using terahertz (THz) spectroscopy in transmission mode to investigate the ground state charge carrier properties. Interestingly, these membranes show excellent transmittance (>70%) at THz frequencies with very high intrinsic THz conductivities (70-100 S/m). The evaluated scattering time and plasma frequency of the free carriers of the COFMs are highly promising for future applications in optoelectronic devices in THz frequencies.

Abstract No: B-2

Dicarbatriphyrin (2.1.1) and its Carbacalix[1]phyrin Analogue: Structure-Property Relationships and Application as a Fe(III) Chemosensor

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Abstract:

Triphyrins are contracted porphyrins with three pyrrole rings in its macrocyclic framework. By introducing phenyl units inside the triphyrin core, carbatriphyrins can be synthesized as an integral component of the macrocyclic structure. Insertion of phenyl groups in the core contributes distinctive characteristics to carbocyclic reactivity, and formation of organometallic complexes.[1] The arrangement of phenyl ring(s) within the macrocyclic framework is crucial in defining their attributes, especially in distinguishing the behaviors of ortho-, meta-, and para-phenylenes when incorporated into either macrocycle[2] or oligophenylene architectures.[3] The carbatriphyrins that have been documented so far have been exclusively in their protonated form or as organophosphorous, i.e. P(V) complex[4]. In this poster, we wish to present the synthesis and characterization of a newly developed stable dicarbatriphyrin (2.1.1), achieved by modifying the [14] triphyrin(2.1.1) framework. Furthermore, the synthesis of carbacalix[1]phyrin (2*.1.1*), a phlorin analogue of dicarbatriphyrin (2.1.1), reveals a chair conformation in contrast to the saddle-shaped structure of its oxidized variant. The dicarbatriphyrin (2.1.1) displays fluorescent emission in solution, which is specifically quenched by Fe (III) ions, underscoring its potential utility as a chemo-sensor for Fe (III) cations.

Abstract No: B-3

Synthesis of Unprecedented Compounds Involving 5th and 6th Group Elements

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Abstract:

Exploratory research serves as the cornerstone of synthetic chemistry, with today's curiosity paving the way for tomorrow's innovations. Over the last ten years, our group has focused on the rational design and synthesis of various closed- and open-shell compounds involving fifth and sixth elements of the periodic table that is boron and carbon, respectively. At the same time, we have developed the modular redox mediated synthetic routes for the synthesis of various unprecedented compounds.

In the poster, we will present our research group's efforts in designing and developing convenient modular routes for synthesizing compounds that contain mono- or bis-alkenes as electron-donor motifs[1], as well as mono- or bis-cyclic/acyclic carbocations and iminium cations, alongside boranes or boryl cations as electron-acceptor motifs.[2] We will elaborate on their utilization as synthons for isolating various open-shell compounds, including radicals, radical cations, cationic diradicals, radical trications, and cationic or heteronuclear diradicaloids under redox (reduction/oxidation) reaction conditions.[3] Moreover, we will discuss the pivotal roles of spin carriers and spin couplers in the resulting electronic properties of these open-shell molecules.

Keywords: Alkenes, Cations, and Radicals.

Abstract No: B-4

Probing Aromaticity with Supersonic Jet Spectroscopy

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Abstract:

Aromaticity is a core concept in chemistry that is even introduced in high school textbooks, yet determining the aromaticity order of simple heterocycles like furan, thiophene, and selenophene remains a challenge. In this poster presentation, we highlight the development and first application of a custom-built, mass-selective electronic and vibrational spectroscopy setup at NISER. This state-of-the-art instrument, designed for high-resolution studies of isolated molecules under supersonic jet-cooled conditions, enables precise investigations into the aromaticity of these five-membered heterocycles. To probe aromaticity, we utilized hydrogen bonding as an indicator of electron density within the ring. The strength of π-hydrogen bonds was measured, revealing a correct aromaticity order: selenophene forms the strongest π-hydrogen bond, followed by thiophene and furan. These results suggest that selenophene is the most aromatic, with thiophene and furan ranking lower. This study not only tries to resolve the long-standing debate about the aromaticity order of these molecules but also demonstrates the effectiveness of our new experimental setup. The ability to test both theoretical predictions and experimental data using this advanced technique opens new avenues for studying aromaticity in complex molecular systems.

Abstract No: B-5

Structure-function studies on plastic degrading enzymes

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Abstract:

Plastics used in packaging of food and beverage consist of polyethylene terephthalate (PET). Plastic wastes persist in our environment for many centuries. Closed-loop bio-recycling of plastic employing plastic degrading enzymes (PEs) is a green alternative to reduce waste. Recently discovered PEs (cutinase, *Is*PETase, etc.) can breakdown PET primarily into its monomer (mono-2-hydroxyethyl terephthalate), terephthalic acid and ethylene glycol. Rational mutants of cutinase and *Is*PETase demonstrated enhanced de-polymerization rates. Catalytic efficiency of PEs depends on temperature, pH, residues and disulphide bonds surrounding the plastic-binding cavity. However, it's challenging to simultaneously boost both degradation rate and thermostability. We cloned and mutated *Is*PETase and a PET hydrolase, and purified both wild-type and mutated PEs in our laboratory. Experiments were conducted at different pHs and oxidizing/reducing conditions. Michaelis-Menten kinetic parameters and binding constants of various sizes of chromogenic substrates were determined. Mutated PEs demonstrated greater catalytic rates compared to their wild-type counterparts. PEs are being engineered based on interactions with docked substrates within the binding groove. We obtained crystals of wild-type and mutant PEs, and co-crystals with PET substrates. Crystal are being screened using an in-house metaljet diffractometer. The structure-function relationship of PEs and modulation of their rates and binding will be presented.

Abstract No: B-6

Modified DNA i-motif: Synthesis and Biochemical Evaluation of *troponyl* DNA C-Rich Sequences

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Abstract:

DNA i-motif is a tetraplex structure, formed through intercalation of hemi-protonated cytosine rich sequence. Modified DNA i-motifs are explored by the structural modification of cytidine nucleoside and phosphate backbone. Most of the cytidine modifications are achieved by introducing benzenoid aromatic moiety at C-5 position of cytosine nucleobase. Recently, our group has reported non-benzenoid aromatic scaffold (Tropolone) comprising DNA which exhibit fluorescence after duplex formation. In the literature, tropolone is constituent of troponoid natural products possessing anticancer, antibacterial, and several other biological activities. Tropolone also exhibits intramolecular hydrogen bonding, fluorescence, and chelation with coordinating metals (strongly with Cu^{2+}). Herein, we describe the synthesis of troponyl DNA C-rich sequences and their i-motif formation by UV-Vis, CD, NMR and fluorescence spectrometric techniques under different pH conditions. We have also examined Cu^{2+} binding affinity with modified troponyl DNA i-motif structures and performed their cell internalization studies.

Abstract No: B-7

Extended Temporal Analysis of Blinking Dynamics in CdSe/ZnS Core-Shell Quantum Dots via Scanning Fluorescence Correlation Spectroscopy

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Abstract:

Single-particle photoluminescence (PL) measurements are essential for investigating charge carrier recombination processes in semiconductor nanocrystals. Photoluminescence blinking studies effectively probe slower processes with timescales longer than 10 milliseconds (ms), while fluorescence correlation spectroscopy (FCS) captures faster processes, typically shorter than 1 ms. In this study, we employed scanning FCS (sFCS) to bridge the millisecond gap, enabling the tracking of carrier dynamics over an extended temporal range from microseconds (μs) to subseconds. Our sFCS data, obtained from surface-immobilized CdSe/ZnS core-shell quantum dots (QDs), were compared with solution-phase FCS studies, revealing qualitatively similar but quantitatively different results. These discrepancies arise from the differing environments of the nanocrystals in the two techniques and the varying temporal windows available for observing carrier dynamics. The most intriguing finding is the non-converging blinking timescale (τ_R) of the QDs in sFCS, despite the extended temporal window (up to 400 ms). This behavior suggests that PL blinking follows power-law statistics, where the mean ON/OFF duration of blinking is influenced by the experimental integration time, leading to blinking across a wide range of timescales.

Abstract No: B-8

Managing Tomorrow's waste: Innovation in Urban Waste Management Technologies Moving towards Zero Liquid Discharge: Liquid Waste Management in Anushaktinagar, Mumbai

♠ Azran Irfan Siddiqui, In-charge (STPs and SPH)

***Shri K.Mahapatra, Director, DCSEM**

***Shri A.S.Yadav, Chief Engineer(ESG)**

***Shri D.Sengupta, Head(MD)**

***Shri S.Bagul, Sr.Supdt.(PHES)**

Directorate of Construction, Services and Estate Management (DCS&EM)

Abstract:

With the imminent global water crisis in foresight, DCSEM proactively initiated setting up of facilities for moving Anushaktinagar towards zero liquid discharge regime. Accordingly, DCSEM has successfully constructed a number of sewage treatment plants (STPs) in the colony. Treated water from these STPs is being utilised for gardening, domestic flushing, as processing water for biogas plants, recharging of a newly developed pond in a recreational facility etc.

The present liquid waste generated in the colony is to the tune of 7200 kilolitres per day (KLD). For the treatment of this liquid waste MBBR technology based STPs have already been installed amounting to a total processing capacity of 6100 KLD. Further, hgSBR technology based STPs amounting to a total installed capacity of 1650 KLD are under planning and construction. Also, a 180 KLD MBBR technology based STP is nearing completion. With all these present and upcoming constructions, the total liquid waste processing capacity of the colony will amount to 7930 KLD, thereby facilitating the processing of 100% of the liquid waste generated in the colony & enabling to move towards zero liquid discharge regime in Anushaktinagar.

Abstract No: B-9

Understanding the Photophysical Behaviour of Some Organic and Inorganic Nano Materials in the Absence and Presence of Some Important Analytes

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Abstract:

The main theme of our research work is to understand the photophysical behaviour of various nano-structured organic and inorganic materials in the absence and presence of various analytes of interest. For this purpose, fluorescent inorganic metal and semiconductor nanoparticles as well as some organic nano-structured materials such as ionic liquids and deep eutectic solvents are used as main research targets. Biologically and environmentally important species such as metal ions, free radicals, biomolecules are used as the chosen analytes. The interaction between various nano-structured materials and selected analytes is investigated by exploiting various spectroscopic and microscopic techniques. Several interesting insights with regard to understanding the critical role of metal nanoclusters (NCs) in enzyme inhibition, catalysis, and sensing applications, the role of semiconductors in modulating the photo physics of organic aggregates, the change in the nano structural organization of ionic liquids in presence of lithium salts, etc. have emerged from these investigations. These research findings have not only provided important knowledge about the fundamentals behind the actions of various nano-structured materials but also suggested that some of these systems have the potential to be used in nanoscale devices. Some of our recent investigations will be highlighted during the presentations.

Abstract No: B-10

Effect of Chain length on the aggregation properties of Surfactin: A Molecular Dynamics Study

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Abstract:

Surfactin is a biosurfactant synthesized by various strains of Bacillus subtilis. It belongs to a class of cyclic lipopeptides and is recognized as one of the most effective biosurfactants due to its exceptional interfacial activity. Structurally, surfactin is composed of a heptapeptide connected to a β-hydroxy fatty acid, forming a lactone bond, with fatty acid chain lengths ranging from C12 to C17. It can significantly reduce the surface tension of aqueous solutions from 72 to 30 mNm^{-1} at concentrations around 10^{-5} M. Surfactin has numerous applications in food, cosmetics, neurodegenerative disease treatment, and enhanced oil recovery, thanks to its unique surface properties and biological activities, including antimicrobial, antifungal, and membranes effects.

In this study, we investigated three different systems based on β-hydroxy fatty acid chains—iso_12, iso_14, and iso_16—to gain insights into their aggregation behavior, water dynamics, micelle shape, and hydrogen bond stability. Additionally, we explored the air-water interface to examine surfactin orientation and surface tension, focusing on how variations in chain length affect these properties, which are crucial for applications in emulsification and foaming. Our findings show that as the chain length increases, the micelle shape becomes more spherical, and at the air-water interface, iso_12 surfactins exhibit lower surface tension.

Abstract No: B-11

Development of Cross-coupling Reactions for Synthesis of Advanced Materials

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Abstract:

Cross-coupling reactions have emerged as powerful tool for the synthesis of organic materials by providing an efficient way to connect C–C and C-heteroatom bonds. Recently, we have developed novel catalytic strategies for the C-C and C-heteroatom cross coupling reactions. Owing to widespread appearance of highly conjugated scaffolds in organic materials, we focused on direct C–H arylation of various heteroarenes using Pd and Cu catalyst. Developed methods exhibit broad substrate scope, easy performance, low catalyst loading and a wide range of functional group tolerance that renders these methods appropriate for the synthesis of useful materials such as pharmaceuticals and organic emmiters. Organic emitters have been used in several applications such as organic light emitting devices (OLEDs), as photosensitizers and markers in biological applications, etc. For OLEDs, it is important to harvest both singlet and triplet excited states of organic emmiters for the high efficiency of the device. We will discuss development of catalytic strategies adopted to synthesize the singlet and triplet harvesting metal-free organic emitters. A few examples of metal-free emitters showing delayed fluorescence, room temperature phosphorescence, and their applications in OLEDs will be presented.

Abstract No: B-12

Cobalt-Catalyzed Reduction of Esters to Alkanes

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Abstract:

Developing a sustainable catalytic method for reducing aryl carboxylates to methyl arenes is desirable and challenging. A well-defined cobalt-catalyzed reduction of carboxylate esters to methyl and allyl arene is developed. This catalytic transformation employs a sub-stoichiometric amount of base, and diethylsilane as a reductant. Diverse alkyl, aryl carboxylate, and cinnamate esters are amenable to this catalytic transformation. Mechanistic investigations revealed the involvement of silyl acetal and silyl ether intermediates and a radical pathway. Catalytic activation of the Si-H bond of silanes, C-O bond of ester and silyl ether intermediates by cobalt is crucial to the success of this exhaustive reduction reaction. Catalytically active Co (I) and Co (III) intermediates are established by mass spectral analyses and a relevant catalytic cycle operating via amine-amide metal-ligand cooperation is proposed.

Abstract No: B-13

Inorganic Functional Materials for Sustainable Energy Applications

Manisha Sadangi [1,2♠], Litun Kumar Pradhan [1,2], Kismat Kumar Sahoo [1,2], Ankita Sahu[1,2], Debayan Mandal [1,2] and J. N. Behera [1,2*]

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Abstract:

The current energy crisis, driven by scarcity of natural gas, coal and their environmental impact, necessitates clean energy solutions. Water splitting and supercapacitors are appealing for their energy conversion and storage applications. A key challenge is to develop transition metal-based electrodes with high energy conversion and storage capacity. Our research includes preparation of VS_2 and a VS_4/rGO nano-composites, which exhibit excellent stability and efficiency for hydrogen evolution reaction with minimal overpotential of 41 mV. Additionally, Metal-Organic frameworks-derived Co_3S_4 nanoparticles demonstrate significant oxygen evolution reaction, with Co_3S_4-3h electrocatalyst achieving an overpotential of 285 mV and stable performance under harsh conditions. Boron-doped carbon, combined with cobalt pyrophosphate, creates a promising hybrid material. Adjusting boron content, B-GC@CPP-4 achieved a specific capacitance of 395.1 Fg^{-1} at 1.5 Ag^{-1}. In the pursuit of a clean and environmentally friendly future, magnetic refrigerator technology based on magnetocaloric effect has been studied as a replacement for conventional refrigeration technologies characterized by inefficient energy use, greenhouse gas emissions. Magnetic study of organically-templated three-dimensional (3D) gadolinium-sulfite with Kagome-type network shows feeble antiferromagnetic correlations amongst Gd (III) ions, which contributes to large magnetocaloric effect with magnetic entropy change extents to $-\Delta S_m = 42.23$ $Jkg^{-1}K^{-1}$ at $\Delta H = 7$ T and 3 K.

Abstract No: B-14

Radiation grafted adsorbent based technology for wastewater treatment

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Abstract:

The high energy radiations play a vital role in altering the properties of exposed polymers depending upon the exposure and experimental conditions. High Energy Radiation like gamma and EB assisted grafting is among widely adopted processes to alter the surface properties of the base polymer for desired applications, particularly functionalisation. The Radiation assisted grafting confer the unique advantages of adding properties of two or more polymers with higher efficiency and better control. Radiation grafting method also have many inherent advantages over conventional chemical grafting method. Properties like hydrophilicity, ion exchangeability, pH sensitivity, thermo-sensitivity, antibacterial property can easily be induced to inert polymers like PP, PE, PTFE or cellulose etc. with good mechanical strength etc. An efficient, low cost, environment friendly and efficient gamma radiation assisted functionalized adsorbent using cellulosic cotton fabric as base polymer for removal of textile-coloured dyes from textile industries and toxic metal ions like As, Cr, Hg has been developed. Cellulose with unique properties like abundance, renewable, biodegradable, low cost, high surface area, easy to modify, good physical strength and easy to fabricate in desired cartridge form was chosen as base material. Mutual radiation grafting method has been adopted to add positively charged or negatively charged functional groups to treat both anionic and cationic coloured dyes released from textile industries, particularly from cotton-based industries

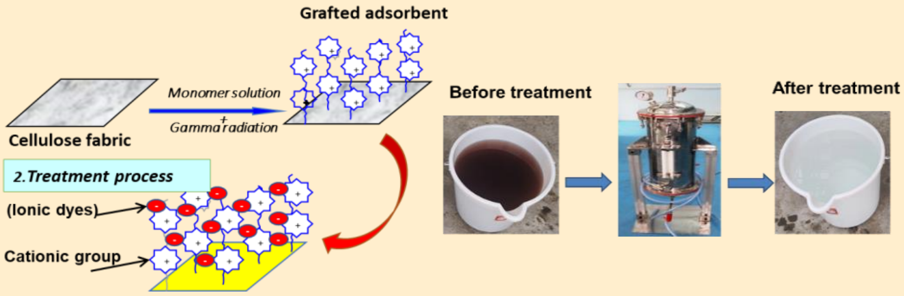

Figure: Gamma Radiation assisted development of anionic and cationic adsorbent & real effluent treatment

References:

1. *N K. Goel et. Al. Radiation Cellulose based cationic adsorbent fabricated via radiation grafting process for treatment of dyes waste water. Carbohydr. Polym. 2015,135, 444–451.*

2. *Misra et al. radiation grafting mediated tailoring of a mercury (Hg (II)) selective adsorbent "RAdMer": Mechanistic insights, uptake performance and reusability evaluation in artificially contaminated groundwater.*
Groundwater for Sustainable Development. 25 (2024) 101139

Abstract No: B-15

Chiral Induction in a Self-Assembled Pd_4 Coordination Cage with Chiral Guests

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Abstract:

The dynamic interaction of coordination bonds within metal-organic cages offers a unique pathway for structural advancement in response to external stimuli, making it a promising approach for building chiral assemblies. This adaptability is vital for the selective synthesis of homochiral structures and the advancement of asymmetric catalysis. Herein we report the self-assembly of an achiral square-planar Pd (II) acceptor with a C2-symmetric tetrapyridyl donor, leads to the formation of a racemic mixture of chiral octahedral cage Pd_4L_2. The existence of this racemic mixture was verified through circular dichroism spectroscopy and single-crystal X-ray diffraction analysis. We incorporated chiral information into the asymmetric cavity of the cage by encapsulating chiral aromatic guests through effective π-π stacking and hydrophobic interactions in an aqueous environment. The introduction of a chiral guest promotes one enantiomeric conformation of the cage over the other, effectively shifting the equilibrium toward a single, enantiopure host-guest complex. While the recognition of chiral guests by a chiral host is a well-established concept, this study offers a striking example of guest-mediated chirality transfer, resulting in the formation of a single enantiopure coordination complex from achiral building blocks.

Abstract No: B-16

Small Molecules Activation by Base Metal Catalyst under Homogeneous Conditions

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Abstract:

Homogeneous catalysis is a crucial area in modern chemistry and chemical technology. The use of base metals as central atoms embedded with different N/S/O donor ligands opens up new pathways for the development of homogeneous catalysis. Our research is mainly focused on various bond activation under homogeneous condition catalysed by base metal complexes. In particular, we have developed different bi and tridentate ligands having S/N/O donor arms for the synthesis of base metal complexes. After successfully characterizing the complexes through various spectroscopic methods, we have utilized those complexes for important organic transformations such as oxidation of toluene and ethyl benzene, also reduction of nitro compounds via hydrosilylation of unsaturated bond. Additionally, we have explored sp^3 C–H alkylation in making C–C bonds using alcohols as sustainable coupling partners in presence of well-defined Cu-catalyst. Various post-functionalization reactions were also carried out including the synthesis of important drug molecules. Currently, our group is also investigating several reactions, including the oxidation of arylacetonitrile using an iron catalyst, deoxygenation reactions of various activated alcohols and carbonyl functionalities using commercially available cobalt catalyst, and N-alkylation reactions with base metal-based catalysts.

Abstract No: B-17

Charge Carriers Dynamics in $CsPbBr_3$-PbSe Epitaxial Nanocrystal Heterostructures

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Abstract:

Lead halide perovskite and chalcogenide heterostructures that share the ionic and covalent interface bonding might be the possible materials for bringing surface stability and superior photoresponsivity to these emerging perovskites nanocrystal. However, in spite of significant successes in the development of halide perovskite nanocrystals, their epitaxial heterostructures and their exited state dynamics with appropriate chalcogenide nanomaterials largely remained unexplored. Keeping the importance of these materials in mind, herein, the epitaxial heterostructure of cubic PbSe with two different faceted orthorhombic $CsPbBr_3$ nanocrystals are reported. These are synthesized following the standard classical approach of heteronucleations of chalcogenide PbSe with $CsPbBr_3$ perovskite nanostructures. With ultrafast transient absorption studies, the facet dependentent charge carrier dynamics of two different shaped $CsPBBr_3$-PbSe as compared to the $CsPbBr_3$ are also established. As these are first of its kind nanostructures that are obtained with epitaxial growth of chalcogenides on halide perovskites, this finding is expected to pave the way for designing other heterostructures and studying their charge carrier dynamics.

Abstract No: B-18

Magnesium-Porphyrin as An Efficient Photocatalyst for The Transformation of CO_2 To Cyclic Carbonates and Oxazolidinones Under Ambient Conditions

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Abstract:

Global warming is one of the most challenging problems for the upcoming mankind with an alarming risein the sea level where Carbon dioxide, the predominant greenhouse gas, contributes predominantly to this worldwide temperature rise. So, any chemical conversion by arresting CO_2 in the form of a valuable chemical compound is of greatimportance and would lead to significant strides towards a greener world. Carbon capture in terms of chemical reaction and sequestration is one of the most effective methods to abate atmospheric CO_2 levels.[1] Various homogeneous and heterogeneous catalytic systems, including metal complexes, metal oxides, organocatalysts, ionic liquids, etc., have been developed already for the cycloaddition of CO_2 with highly strained three-membered rings like epoxides, and aziridines.[2] Among them, metal complexes like metal salens, or metal porphyrins are much more superior due to their enormous catalytic efficiency. Employing a simple Mg-porphyrin metal complex as a visible light photocatalyst for the photochemical cycloaddition of CO_2 with epoxides or aziridines to furnish various cyclic carbonates or oxazolidinones under solvent-free and at ambient conditions presents a promising strategy towards the abatement of global warming. This greener and sustainable approach applies to a wide range of substrates, including a library of terminal and internal epoxides and aziridines.

Abstract No: B-19

Main Group Metal Complexes: Synthesis, Reactivity, and Catalytic Applications

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Abstract:

Main group metal complexes have emerged as promising catalysts in organic transformations, offering unique reactivity and selectivity. This work focuses on the synthesis of novel main group metal complexes, including magnesium, zinc, boron, aluminum, germanium and tin, and their catalytic applications in the reduction of a broad range of organic substrates. The reactivity studies of these complexes reveal the ability to activate challenging bonds, thereby enabling selective transformations of alkenes, carbonyl, and heterocumulenes under mild conditions. Detailed spectroscopic characterization, including NMR, IR, and X-ray crystallography, confirmed the structure of the synthesized complexes. The catalytic efficiency and reactivity of these compounds were investigated using various substrates. Mechanistic insights into the catalytic cycles were explored through intermediate isolation, highlighting the roles of the ligand and metal center in bond activation processes. Our findings expand the understanding of main group metal catalysis, showcasing the potential of these complexes in sustainable and selective organic reductions. This study provides new perspectives on the reactivity of underexplored main group organometallic systems and their potential for industrial applications in catalysis.

Abstract No: B-20

Inelastic Gas-Surface Scattering: Effect of Incident Angle

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Abstract:

Energy transfer between gas molecule and the metal surface during the gas-surface scattering has been a broad area of research due to its importance in heterogeneous catalysis and energy storage.[1,2] Recently, Wodtke and coworkers performed a molecular beam experiment to study the formaldehyde (HCHO) scattering from gold surface and found mode specific excitation of the HCHO molecule.[3] In order to probe the transfer of translational energy into rotational energy our group has exclusively modeled this scattering by varying the surface temperature and collision energy using classical trajectory simulation.[4] In the current work the simulations were extended to investigate the effect of incident angle at different collision energies on the energy transfer process.

Abstract No: B-21

Advancements in Corrole Chemistry: Synthesis, Properties, and Emerging Applications

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Abstract:

Porphyrin is an essential natural macrocycle, playing a crucial role in hemoglobin and chlorophyll, making it a key subject in scientific research. Recently, corroles, a class of contracted porphyrins, have garnered significant attention due to their distinct structural and spectroscopic properties. Resembling both porphyrins and corrins, corroles are seen as intermediates between these two classes. Advances in synthetic methodologies have brought corrole chemistry to the forefront, particularly because of their ability to stabilize higher oxidation states of metals due to their contracted core. Researchers have synthesized various corrole and metalocorrole complexes, demonstrating their potential in areas like catalysis, sensing, medicinal chemistry, and dye-sensitized solar cells. Despite this progress, some aspects of corrole chemistry remain underexplored. This work seeks to address these gaps by focusing on the synthesis and spectroscopic properties of metalated corroles and examining different synthetic methodologies involving corroles and other macrocycles, as well as their potential applications in various fields.

Abstract No: B-22

Template Assisted Synthesis of Higher Order Catenane and Donor-Acceptor Catenane Using Click Reaction

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Abstract:

We achieved synthesis of [2], linear [3], radial [4]catenane in a one-pot by consecutive ring closing two, four, and six-click reactions between suitable coupling partners. Yields of the isolate templated-catenane decrease from lower to higher-ordered catenane (40%, 12%, and 4%), probably due to the bite angle as well as the flexibility of the reacting partners. The synthesized templated [2]catenanes have free pyridine-diamide threading unit suitable for post-functionalization. It is further threaded at the free Co(III) binding site to achieve two [3]pseudorotaxanes with suitable groups at the terminal for click reaction. These units were then joined, forming a macrocycle, using click reaction, giving metalated linear [5]catenane in 40% yield. Successful optimization of synthesis of catenane using non-labile Co(III) ion template encourages us to design and functionalize donor (D) and acceptor (A) fluorophores into catenane topology using click reaction. The [2]catenane is tailored to have fluorene (donor group) and benzophenazine (acceptor). The synthsized D-A catenane is a blue emitter and shows motion induced change in fluorescence, so can be used for temperature and viscocity sensor. All synthesized monomers and catenanes were purified by column chromatography and characterized by ^{1}H-NMR, ^{13}C-NMR, ESI-MS spectroscopy and X-ray crystallography. Demetalation was achieved using Zn/CH_3COOH.

Abstract No: B-23

En Route to Recyclable Semi-Heterogeneous Photocatalysis with Photoinert-$CeCl_3$

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Abstract:

Our study proposes an approach to semi-heterogeneous photocatalysis, focusing on recyclability challenges. We developed a method employing visible light with photoinert anhydrous-$CeCl_3$, rendering it into a reusable semi-heterogeneous photocatalyst. Despite being photoinert and insoluble in organic solvents, anhydrous $CeCl_3$ formed a transient charge-transfer (CT) complex in acetonitrile, denoted as $CeCl_3$ - NXS (NBS or NCS), due to the strong oxophilicity of trivalent cerium towards oxygen. This complex facilitated visible-light absorption, leading to the photoexcitation of the Ce(III) complexes and conversion of Ce(III) centers into potent reductants, donating electrons to NXS. As a proof of concept, we demonstrated organic reactions where NXS, upon accepting electrons, generated halide radicals, allowing the synthesis of *gem*-dihaloketones under sunlight from terminal aromatic alkynes via C-X cross-coupling reactions. Significantly, $CeCl_3$ exhibited recyclability without notable decomposition, demonstrated by its regeneration and isolation through simple filtration post-reaction, underscoring its potential for prolonged use.

Abstract No: B-24

Synthesis of Unprecedented Compounds Involving 5th and 6th Group Elements

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Abstract:

Exploratory research serves as the cornerstone of synthetic chemistry, with today's curiosity paving the way for tomorrow's innovations. Over the last ten years, our group has focused on the rational design and synthesis of various closed- and open-shell compounds involving fifth and sixth elements of the periodic table that is boron and carbon, respectively. At the same time, we have developed the modular redox mediated synthetic routes for the synthesis of various unprecedented compounds.

In the poster, we will present our research group's efforts in designing and developing convenient modular routes for synthesizing compounds that contain mono- or bis-alkenes as electron-donor motifs[1], as well as mono- or bis-cyclic/acyclic carbocations and iminium cations, alongside boranes or boryl cations as electron-acceptor motifs.[2] We will elaborate on their utilization as synthons for isolating various open-shell compounds, including radicals, radical cations, cationic diradicals, radical trications, and cationic or heteronuclear diradicaloids under redox (reduction/oxidation) reaction conditions.[3] Moreover, we will discuss the pivotal roles of spin carriers and spin couplers in the resulting electronic properties of these open-shell molecules.

Keywords: Alkenes, Cations, and Radicals.

Abstract No: B-25

High Power Plasma Arc System and its application in 200 kg/hr Plasma Pyrolysis Plant for 5TPD Biomedical Waste Treatment Facility at Varanasi

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Abstract:

Plasma Pyrolysis is basically thermal disintegration of organic mass precisely polymeric and aromatic hydrocarbons into lower hydrocarbons at high temperature of nearly 1000º C with oxygen starved environment created by plasma torch system. Hence, the role of plasma torch system in plasma pyrolysis process is predominant. IPR has successfully designed and developed plasma torch system up to 320kW power for continuous operation. A 100kW plasma torch system has been successfully tested for 120 hours separately and total 3 nos of this 100kW torch systems are mounted in an advanced refractory lined primary chamber of 200kg/hr plasma pyrolysis plant under a DPR project on establishing 5TPD Common Biomedical Waste Treatment Facility (CBMWTF) at Varanasi, UP. This plant also has secondary chamber, gas cleaning system and 30-meter chimney as per CPCB/MOEF norms. The 200kg/hr capacity plasma pyrolysis system is going to be tested at IPR Gandhinagar before shipment to Varanasi. This advanced facility will also have Autoclave, Effluent Treatment Plant (ETP), and Shredder etc.

The high-power plasma torch system converts electrical energy into thermal energy for generating high temperature in the primary chamber. IPR has successfully designed graphite electrode-based plasma torch system that has more than 90% electro-thermal efficiency, in addition, it has been developed for continuous operation. Further, it requires very low-capacity cooling system unlike conventional water-cooled plasma torches that takes back nearly 30% of thermal energy from the torch system.

Further, IPR has also successfully designed and developed 320kW plasma torch system that could be deployed for even higher capacity plasma pyrolysis/gasification plants in future.

Abstract No: B-26

Hydrogen spillover inspired alkaline hydrogen evolution and oxidation on interface-rich metallic Pt-supported MoO_3

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Abstract:

The sluggish HER/HOR reaction kinetics in base is the key issue for commercializing alkaline fuel cells and electrolyzers. It's also quite challenging to decrease the noble metal loading without sacrificing performance. Herein, we report hydrogen spillover induced improved HER/HOR activity on platinum-supported MoO_3 in base. The catalyst exhibited 66.8 mV overpotential to reach 10 mA/cm^2 current density with 41.2 mV/dec Tafel slope for HER. For HOR, the catalyst possesses mass-specific exchange current density of 505.7 mA/mg$_{Pt}$, which is far better than Pt/C. The hydrogen binding energy is key descriptor for the HER/HOR. We found H-spillover from Pt to MoO_3 enhances the Volmer/Heyrovsky process, which enhances HER/HOR performance. The work function value of Pt [$\Phi = 5.39$ eV) is less than that of β-MoO_3 (011) [$\Phi = 7.09$ eV], which revealed charge transfer from Pt to β-MoO_3, suggests the feasibility of H-spillover. We propose that the H_2O or H_2 dissociation takes place on Pt and interfaces to form Pt–H_{ad} or (Pt/MoO_3)–H_{ad}, and some of the H_{ad} shifted to MoO_3 sites through hydrogen spillover. Then, H_{ad} at the Pt or interface, and MoO_3 sites reacted with H_2O and HO^- to form H_2 or H_2O molecules, thereby boosting the HER/HOR activity.

Abstract No: B-27

Synthesis of 3-Aryl Benzofurans Via Nickel Catalysed Tandem Reaction

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Abstract:

Benzofuran is an interesting class of heterocyclic core and found in many natural products and bioactive molecules. In particular, 3-aryl benzofurans have received much attention in recent years due to their diverse application ranging from medicinal chemistry to material sciences.[1] Hence, developing new and efficient synthetic methods for these molecules is always needed.

Tandem reactions play a vital role in synthetic chemistry because these reactions can afford multiple bonds and molecular complexity in a single synthetic operation without isolating the intermediates.[2] Synthesis of heterocyclic compounds through a tandem reaction is always challenging task. Recently, we have developed a nickel catalysed desymmetrization of disubstituted malononitriles yielding α-cyano carbonyl compounds in good to excellent yields.[3] We also developed a nickel catalysed tandem synthesis of 2-Aroyl benzofuran[4] ,In continuation, we disclose a nickel catalysed tandem reaction of α-aryloxy acetonitrile affording 3-aryl benzofurans. Detailed mechanistic studies and substrate scope will be presented in this conference.

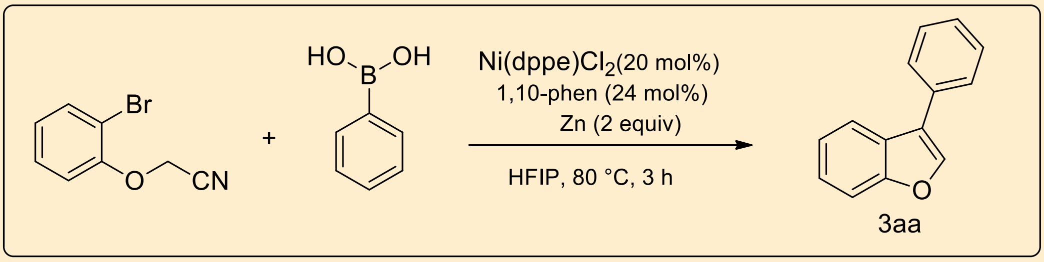

Figure: *Nickel catalysed tandem reaction*

PHYSICS

Abstract No: C-1

Non-Recoil Model for Fission Product Release from a Ruptured Fuel Pin in a Fast Reactor

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Abstract:

It is very important to ensure core safety while operating any sodium-cooled fast reactors (SFRs). The increased safety level in these reactors demands a reliable neutronics instrumentation system to monitor any fuel pin failure during operation. In the case of the wet phase of clad rupture, to extract reliable information based on the received signal in the delayed neutron detector, the initial key step to estimate the release rate of radioactive solid fission products, including delayed neutron (DN) precursors through the clad openings into the coolant sodium.

Estimating the release rate is a complex process due to its strong dependence on various factors, such as material properties, the nature of the openings (regular vs. irregular), and the diverse release mechanisms involved. The 'prompt recoil model (PRM)' is a simplified model to estimate the release rate and is being used. Additionally, an alternative analytical model, known as the Modified Non-Recoil Model (MNRM), has been worked out to account for the intermediate decay of fission products before reaching the coolant. The study shows that the calculated release rate of DN parent nuclides using MNRM with enhancement factor (K') = 1 is only 10% of the release rate estimated using PRM with enhancement factor K=5, while the total release rate for the DN daughter nuclide is 43 % less than that estimated using PRM. Upon validating the model, it is observed that the MNRM model closely aligns with the experimental values.

Abstract No: C-2

Effect of Ion beams on 2D and 2D materials and understanding electron-phonon coupling

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Abstract:

Electron-phonon (e-p) coupling is an important parameter in condensed matter physics to understand the major scattering mechanism that limits charge carrier mobility in bulk semiconductors, contributes to optical absorption in indirect-gap semiconductors, conventional superconductivity, and a measure of the thermal effects in solids. When an energetic ion beam interacts with the matter, it loses its incident energy through nuclear (S_n) and electronic (S_e) energy loss processes, and the electrons are coupled with the phonons inside the materials. Depending on the e-p coupling strength, it can generate thermal spike in the matrix, affect bandgap in 1D materials, and excitons in 2D materials. The poster will mainly focus on different examples of the e-p coupling effect due to ion irradiation in 1D and 2D materials.

Abstract No: C-3

Current-induced spin polarization in Rashba-Dresselhaus systems under different point groups

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Abstract:

Non-magnetic materials without inversion symmetry typically exhibit strong Rashba spin-orbit coupling (SOC), enabling the well-known Rashba Edelstein effect where an external electrical current induces transverse spin polarisation. In this work, we demonstrate that electrically induced spin polarisation in non-magnetic materials, for example, electronic systems within quantum-well geometries, can significantly be influenced by the system's point-group symmetries, such as Cn and Cnv. These symmetries allow various linear and higher-order momentum, k−varying SOC Hamiltonian. Specifically, we show that surfaces having Cn point-group symmetry, which permits specific linear and cubic Rashba and Dresselhaus SOC terms, can lead to both orthogonal and non-orthogonal spin polarisations with respect to the applied field. In contrast, surfaces with Cnv symmetry exhibit only transverse spin polarisation, regardless of the linear and cubic SOC terms. We further find contrasting spin polarisation for cubic-in-k SOC as compared to the linear-in-k SOC when energy is varied, for example, through doping. Additionally, we show that the surfaces with Cn symmetry may exhibit persistent spin current, depending on the relative strength between different momentum-dependent SOC terms. Our finding emphasizes the significance of crystal symmetry in understanding and manipulating induced spin polarisation in noncentrosymmetric materials, especially in surface/interface systems.

Abstract No: C-4

Development of novel technologies for Lu-177 and Y-90 based Therapeutic Nuclear Medicine applications

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Abstract:

Lutetium-177 (Lu-177) based peptide targeted therapies have now become an indispensable tool globally for management of several cancer types. BRIT has recently developed and commissioned a facility for rapid isolation of no carrier added (NCA) Lu-177 from irradiated enriched Yb-176 targets. Unlike carrier added Lu-177, NCA Lu-177 offers the advantage in terms of high purity and specific activity. Producing clinical-grade NCA Lu-177 is challenging due to complexity involving separation chemistry of identical lanthanide elements and achieving the required purity for medical end use. The present touchscreen-based, HMI and PLC-controlled technology developed features a compact, multistage extraction chromatography-based separation module with automated modes, minimizing radiation exposure and reducing processing time. NCA Lu-177 using the above technology was successfully isolated, labelled and clinically deployed for cancer care. This development positions India among the few countries with this capability.

BARC developed Yttrium-90 (Y-90) Glass Microsphere (Bhabhasphere), a particulate form of drug (size 20-40 µm) for trans-arterial radioembolization therapy targeting late-stage liver cancers. These particles need to be slowly infused directly into the liver cancer via a hepatic artery in large volume of saline (60 mL). Due to its dense particle nature (density 3.42g/cc), administering Y-90 Bhabhasphere in patients presents challenges. BRIT developed a Dose Delivery System that overcomes all challenges, ensuring safe and uniform administration into the liver cancer. Used successfully in major Indian hospitals, it achieved over 95% administration efficiency and meets clinical requirements. The development of this delivery system enabled successful clinical implementation of this Y-90 Bhabhasphere therapy to poor cancer patients of the country at about 1/5th the imported cost.

Abstract No: C-5

Development of high-density WC pellets for Lower Axial Shielding of FBTR

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Abstract:

Fast Breeder Test Reactor (FBTR) at Kalpakkam is dedicated to fast reactor research since its first criticality in 1985. But, the life of the FBTR is limited by the mechanical degradation (loss of ductility) of permanent structure like grid plate due to cumulative neutron irradiation damage over time. Based on neutronic, chemical compatibility with Sodium and metallurgical studies, tungsten carbide (WC) has emerged as the most suitable shielding material for the grid plate to extend the service life of FBTR.Hence, high density WC pellets synthesized through powder metallurgy route are routinely used as shielding material in all fuel sub-assemblies for the forthcoming campaigns of FBTR by replacing the existing bottom axial SS 316 pins so that the fluence seen by the grid plate can be minimized. Synthesis of high-density WC (15.6 g/cc; 99.8% of theoretical density) pellets without any sintering additive was overcome by adopting novel spark plasma sintering technique under optimized temperature and uni-axial compaction pressure of 1740°C and 35 MPa, respectively. To qualify the material for the application in FBTR, the structure, chemistry, thermo-physical properties as well as the evolution of defects structure and texture have been studied.

A detailed Rietveld analysis of Synchrotron X-ray diffraction (SXRD)pattern confirmed the presence of WC (99.30 wt %) with a minor amount of W_2C (0.69 ± 0.068wt %). The evaluated lattice parameters: a = 0.291 ± 0.001 nm and c = 0.284 ± 0.001 nm with c/a ratio of 0.976 in the WC lattice indicates a weak crystal anisotropy. Texture investigation was carried out using pole figure analysis and the pole figure with ***mrd*** (**m**ultiples of **r**andom **d**ensity) values of 1.3 indicate that the pellet prepared using SPS technique is weakly textured (close to random). Micro-chemical analysis using EPMA suggests the presence of free carbon. The mean coefficients of thermal expansion values along a- and c-axis are estimated to be 4.55×10^{-6} $K^{-1}$and $5.73 \times 10^{-6} K^{-1}$ respectively. Thermal conductivity at RT is found to be 121 $Wm^{-1} K^{-1}$ which comes down to 58 $Wm^{-1} K^{-1}$ at 1273 K. Similarly, the dynamic Young's modulus at room temperature is found to be 664 ± 3 GPa with a 13% decrease at 1273 K. The variation of the Debye temperature (630 K to 585 K) and Grüneisen parameter (1.41–1.45) for the alloy is also estimated using QHM.

A systematic measurement of thermodynamic properties in combination with the quasi-harmonic Debye-Grüneisen modelling (QHM) approach was adopted for the estimation of isobaric heat capacity, bulk and lattice thermal expansion thermal diffusivity and conductivity as well as the dynamic elastic moduli of sintered WC.

Aberration corrected Z-contrast HRSTEM-HAADF analysis showed the presence of stacking faults in {1-100} planes. It has also been identified that a [1-100] screw axis causes the crystal orientation to rotate by 90º from [2-1-10] to [0001] direction at the stacking fault. Through STEM-**i**ntegrated **D**ifferential **P**hase **C**ontrast (**iDPC**) imaging, it has been shown that the occurrence of a double layer of {1-100} carbon planes is responsible for this rotation of the adjacent {1-100} tungsten plane by 90°, leading to the formation of stacking faults.

A detailed and systematic study on the structure and thermodynamic properties enabled to qualify the material for the lower axial shielding application in FBTR, details of which will be presented at the conclave.

Abstract No: C-6

Configurable Slit Unit for the Multi Object Infrared Spectrometer

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Abstract:

At TIFR we have designed and developed a Configurable Slit Unit (CSU) to generate a multi-slit configuration, a long slit, or an imaging aperture at the entrance focal plane of the Multi-Object Infrared Spectrometer being designed for the Devasthal Optical Telescope. The CSU, consisting of 10 bars moving pair-wise in opposition, is capable of creating up to 5 slits for spectroscopy at any location within the 86 mm x 86 mm field of view of the spectrometer. Keeping in mind the requirements of near-infrared spectroscopic observations, the CSU is designed to operate at a temperature of 120 K. The regulated motion of the slit-bars is achieved using piezo- electric walkers and the slits are positioned with an accuracy of ~10 µm via a controlled position-sensitive loop. The modular nature of the design makes the slit unit to be upgraded independently to increase the multiplexing capability. The primary science goals of the spectrometer include studies of protostars, proto-planetary disks and exoplanet atmospheres. We shall present the design & development of CSU lab model functional at TIFR.

Abstract No: C-7

Nuclear Agriculture: Developments and Accomplishments

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Abstract:

Nuclear technologies provide unique solutions in the agricultural sector for crop improvement, production and protection, ensuring environmental sustainability and food security. In order to achieve higher productivity, suitable crop varieties with improved characteristics have been developed by inducing heritable changes through mutagenesis. Successful use of gamma rays has resulted in the development of 62 improved Trombay crop varieties in cereals, oilseeds and pulse crops. These varieties have been extensively cultivated by the farmers all over India and helped in enhancing their farm income. Significant progress has also been made in the development of novel mutants in banana, pineapple, turmeric, ginger and ornamental crops through *invitro* mutagenesis. The radiation-polymerized superabsorbent hydrogel, which aids in soil moisture retention, has been shown to improve plant growth in rainfed areas. Radiation-depolymerized chitosan functions as plant growth modulator enhancing crop productivity in stressful environments. For bio-control of plant pathogens, the use of the radiation-induced *Trichoderma* mutant, 'Tricho-BARC' has been very successful. Radiation based sterile insect technique (SIT) and biopesticides have been developed for the management of insect pests. These nuclear technologies which have benefited farmers, traders and end-users, will continue to play a significant role in addressing the food and nutritional security of our nation.

Abstract No: C-8

Recent Developments at BARC-TIFR Pelletron Linac Facility

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Abstract:

The BARC TIFR Pelletron Linac Facility comprising a 14 MV Pelletron and a superconducting Linac booster (lead plated cavity with $\square_{opt}$=0.1, 150MHz) has been a major center for heavy ion-based research in nuclear, atomic, condensed matter physics, interdisciplinary areas as well as application-based research programmes. The facility has been scientifically stimulating and very productive resulting in about 165 Ph.D. theses and over 825 journal publications over last three decades. Development of the associated facilities and instrumentation to improve the performance of the accelerator is an ongoing process. A beam scanner (20 mm x 20 mm) and a beam chopper (pulse duration □ ms two minutes), based on the beamline steerer are implemented. Micro-controller-based instrumentation and interface has been developed for control and monitor of the cryogenic parameters, beam diagnostics and beam transport devices. The upgrade of the control system to more modern and efficient platform, namely, Experimental Physics and Industrial control System (EPICS), is in progress. A NbTi based helium level sensor has been developed indigenously. To widen the acceptance of the Linac to heavier beams, the development of low beta (β_{opt}=0.07) Niobium cavity in the first Linac module has been initiated. Details will be presented.

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Abstract No: C-9

Reactor anti-neutrino measurement with the ISMRAN setup at BARC

Dipak Kumar Mishra

Abstract:

Neutrinos are considered to be the most elusive particle in standard model of particle physics. One of the copious sources of neutrinos are nuclear reactors, where on an average 6 neutrinos are produced per fission of the reactor fuel. In recent years, at very short baseline (<20m) when the measured yield of reactor anti-neutrinos was compared with theoretical calculations, a 6% deficit was reported which has been attributed either due to the existence of sterile neutrino. On the application front, since these neutrinos comes of reactor core with negligible interaction with matter and travels larger distances. This property can be utilized to remotely monitor reactors using anti neutrinos. A detailed study of the measured anti-neutrino energy spectra over longer period of time can shed insights on the fuel composition in reactors. To join the international effort for detection of reactor-based neutrinos, BARC have developed and installed a 1-ton size plastic scintillator-based detector array called Indian Scintillator Matrix for Reactor Anti-Neutrino (ISMRAN) in DHRUVA reactor hall. The experiment consists of 90 plastic scintillator bars (PS), each of dimension 10cm x10cm x 100cm, arranged on a movable base structure. The detection of anti-neutrinos from fission is done via inverse beta decay (IBD), where the anti-neutrino interacts with quasi-free protons in PS bars and produces a positron and a neutron. The positron signature is called "prompt" signal and that from neutron is called "delayed" signal. At a distance of ~13 m from the reactor core, with a moderate efficiency of 16%, the number of anti-neutrino events detected at reactor power 100 Mwth is ~60 per day.

With the experience gained from the ISMRAN experiment, we are proposing an experiment in upgraded Apsara reactor for detection of reactor anti-neutrinos using coherent elastic scattering with nucleus (CvENNS).

Abstract No: C-10

Development and Deployment of RRCAT Laser Technology in India Nuclear Program

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Abstract:

High power solid-state lasers with fiber optic beam delivery have potential applications in nuclear field for remote cutting and welding applications. RRCAT has indigenously developed high power Nd:YAG lasers of up to 1.5 kW average power and 30 kW peak power and 1 kW CW fiber lasers. Laser cutting and welding technology has the advantage of non- contact nature, remote operation, and low heat affected zone as compared to conventional technologies. Remotely operable laser cutting technology has been developed & deployed successfully for various in-situ operations in reactors such as cutting of bellow lips during en-masse coolant channel replacement (EMCCR) campaign, removal of single selected coolant channels for post-irradiation examination for life enhancement studies, cutting of up to 30 mm thick pipelines, underwater cutting of fuel tubes, etc. for refurbishing and maintenance of Indian PHWRs, LWRs and research reactors. The use of laser technology has resulted in enormous saving of manrem consumption and reduction in maintenance shutdown time of reactors. For societal applications, laser micro-welding technology for I- 125 and Ir-192 brachytherapy capsules for cancer treatment has been developed. Towards front end of fuel cycle, laser welding system for PFBR fuel pins has also been successfully developed and deployed at FF, Tarapur.

Abstract No: C-11

LIGO-India activity and Test & Training facility at RRCAT

Brijesh Chandra Pant

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Abstract:
Laser Interferometer Gravitational-Wave Observatory (LIGO) - India Project is for setting up of an advanced gravitational-wave observatory at Aundha, in Hingoli district of Maharashtra as a collaborative project between a consortium of Indian research institutions, and the LIGO Laboratory in USA. As a part of pre-project activity, a Test and Training facility has been constructed at RRCAT in recent years. The facility includes a 10-Meter interferometer for controls training of the Fabry-Perot enhanced Michelson interferometer, pre-stabilised laser, Suspensions fibre drawing, Optics metrology and prototypes of vacuum chambers for training on installation of internal seismic isolation systems (ISIs). Also, experiments and research for 3rd generation Gravitational wave detectors are planned in the facility. The poster aims to present the various challenges involved in construction, training, and installation & commissioning of the Gravitational wave Observatory at Aundha, Maharashtra and current status of the Training and Testing facility.

Abstract No: C-12

Experimental implementation of quantum algorithms in linear optics

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Abstract:

Quantum optics related research activities at IGCAR involve generation of single photons, entangled photons and light beams carrying orbital angular momentum, and their applications. In the past few years, phenomena like entanglement distillation, reconstruction of quantum states based on interferometry have been experimentally studied. Furthermore, a novel polarimetric method for generating full Poincare beams has been devised. Realization of q-plates with passively controllable retardance, which are essential for the controlled conversion of spin angular momentum (SAM) to orbital angular momentum (OAM) of light, was designed and demonstrated experimentally. The Deutsch algorithm was also experimentally implemented in the phase oracle. In line with the objective of the National quantum mission, experimental implementation of quantum key distribution protocols in free space and in optical fiber are now being attempted. On the theoretical side, SAM and OAM are being studied as a platform for implementing coin-based quantum walks, which are an alternate way to study quantum algorithms. A criterion for identifying quantum-walk accessible states is made and a prescription for experimentally realizing them through spin and orbital angular momentum composite space is provided. The more generalized definition of quantum walks is also proposed, and manifestation of Parrondo's paradox in these is made.

Abstract No: C-13

Developments and Studies on Structural Stability of Nuclear Materials at High pressure and Temperatures

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Abstract:

High pressure research is being carried out at MSG, IGCAR for many decades starting from the first experimental report of electrical resistivity of U and Th at high pressure. Development of various experimental tools and techniques has led to exploring many facets of condensed matter physics at high pressure. Few important developments are, fabrication of indigenous Mao-Bell type Diamond Anvil Cell (DAC), setting up of Laser Heated DAC (LHDAC) facility and in-situ High Pressure- High Temperature (HP-HT) XRD facility employing both lab source and at INDUS 2.

Structural stability studies have been carried out on various classes of systems few of which are mentioned below. The studies on uranium intermetallic compounds reveals significant structural transformations and phase behavior that enhance the understanding of electronic properties and these studies have enabled establishing structural stability maps at high pressure. Detailed systematic studies on pristine and substituted rare earth sequioxide (Re_2O_3) systems has led to establishing pressure composition structural phase diagram and the role of micro strain in stability of different phases. Also, microscopic origin of structure property correlation has been established among transition metal borides.

In-situ HP-HT XRD studies on, (i) U_3O_8 reveals enhanced kinetics of pressure induced structural transition and (ii) in the case of $Cd_{0.9}Zn_{0.1}Te$, detector material, structural P-T phase diagram been established along with understanding the mechanism of the polymorphic transition in these systems. Using LHDAC facility Manganese Monocarbide (MnC) was synthesized and was estimated to have hardness of 40 GPa, positioning it as a potential superhard material.

Abstract No: C-14

Resonant and Non-Resonant Energy Transfers in Weakly Interacting Dispersive Waves

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Abstract:

Wave dynamics is important in many fields, such as oceanography, plasma physics, and astrophysics. They are often described by dispersive, non-linear partial differential equations. These equations explain how energy spreads from excited waves through nonlinear interactions consisting of resonant and non-resonant waves. When wave amplitudes are small, resonant interactions typically dominate energy transfer, a study area known as wave turbulence. However, the effectiveness of these interactions is still unclear, and quasi-resonant interactions are not well understood. Moreover, full-scale, three-dimensional simulations of hydrodynamics are complex and time-consuming, and they often make it hard to see how energy transfers happen through resonant interactions.

To address these challenges, this study derives new one-dimensional mathematical models with quadratic non-linear terms, which result in three-wave resonant interactions. These models span a spectrum of dispersion relations: 1) sinusoidal and algebraic relations for exact resonance, and 2) Rossby and internal-gravity waves for quasi-resonance. Also, each model is characterized by distinct non-linear terms for varying degrees of nonlinearity. By exploring these simplified models, we found out that the resonant energy transfer is subdominant even for lower degrees of nonlinearity.

Abstract No: C-15

Development of Semiconductor Quantum Structures at RRCAT and Their Applications

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Abstract:

Semiconductor quantum structures have played a crucial role in modern era. Their development has been marked by significant discoveries and advancements. At RRCAT, semiconductor quantum structures with atomically smooth interfaces are epitaxially grown for the development of quantum well lasers and quantum well/dot detectors, monocrystalline DBR, polariton and spin photonic devices. These quantum structures are mainly grown using group III-V and III-N material systems through MOVPE and MBE techniques. The structure, optical, and electronic transport properties of the grown structures are initially accessed using HRXRD, optical spectroscopy and electronic transport measurements under various operating conditions. Finally, atomic level perfection and ultra-low disorders are evaluated using TEM, magneto-PL/SPV, and quantum Hall measurements. The designed quantum structures act as the active medium for laser diodes, leading to the realization of semiconductor laser diode arrays. At RRCAT, laser diode arrays achieved a maximum power output of 25 W and 3 W under quasi-continuous and continuous operation, respectively, at 980 nm. With improvements in heat removal and precision bonding, packaged laser diode arrays were successfully used to pump solid-state media which delivered up to 51.5 W in continuous mode operation. Additionally, in-house developed detector devices are utilized to detect ionizing and non-ionizing radiations, and a few of those were deployed for in-house applications at RRCAT.

Abstract No: C-16

Low emittance operation of Indus-2

Ali Akbar Fakhri (On behalf of the Indus-2 team)

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Abstract:

Indus-2 is working as a national facility for the synchrotron radiation users across India. To increase the spectral brightness of the emitted synchrotron radiation, its horizontal emittance is reduced from ~135 nm-rad to ~45 nm-rad at 2.5 GeV and the vertical emittance is reduced by about 20%. These results have been obtained by optimizing the optics to make it relatively insensitive to coupling errors thereby enabling us to get the desired beam characteristics. Extensive studies have been carried out to further reduce the effect of errors by reducing closed orbit distortion with the help of beam-based alignment of all Beam Position Monitors and the simultaneous operation of slow orbit feedback and tune feedback systems. The beam characterization is done with help of LOCO code (Linear optics from closed orbits). For smooth injection, ramping and operation of Indus-2 in the above low emittance optics, power converters of the quadrupole magnets have been augmented to give higher currents and have been augmented with improved cooling and safety interlock setting levels. This low emittance optics is applied on Indus-2 for regular user operation. As a result of this, significant improvements in the synchrotron beam quality have been observed at the beamlines.

Abstract No: C-17

Joining Innovations at RRCAT

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Abstract:

RRCAT has innovated several crucial joining technologies to meet the requirements of projects of RRCAT and other DAE units. These technologies include (i) development of fully austenitic weld metal in TIG welds of austenitic stainless steels (SS) with low magnetic permeability using nitrogen alloying through shield gas, (ii) implementation of ultrahigh vacuum compatible activated TIG welding of austenitic SS on shop floor, (iii) development of technology for automated TIG welding applications (TATWA) for porous to solid tubular joints in SS and titanium (special purpose machine), (iv) development of vacuum cast thread filled tubular joints between aluminum/Ti alloys and stainless steel, (v) joining bi-metallic tubular components through vacuum brazing (niobium/titanium/copper/aluminum alloys on one side and stainless steel on the other side), (vi) ceramic to metal joining for various feed through applications, (vii) titanium to tantalum TIG welding and joining of tantalum to stainless steel using TIG brazing for electron LINAC applications.

The new methodologies/techniques developed essentially address the ongoing and future requirements and have strong potential for deployment in industry as well.

Abstract No: C-18

QND Measurement of Tantalum-based Heavy Fluxonium Qubit

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Abstract:

Among the various platforms for quantum information processing, superconducting qubits have been leading the race for fault-tolerant computation. In the past, multi-qubit processors have only used transmon qubit designs. Transmon's weak anharmonicity limits the scalability of quantum processors, a direct consequence of restricted parameter space of operation, fuelling motivation to look for alternatives. Recently, fluxonium qubit has emerged as a contender for building a superconducting quantum processor. Fluxonium qubits have potential to excel over transmons due to their inherent advantages of high coherence times and large anharmonicity. One of the crucial steps in realizing fault-tolerant quantum processor is high-fidelity quantum non- demolition (QND) measurement. Here, we will discuss experiments to characterize and optimize measurement, and demonstrate high QND fidelity. Further, we will discuss back-action of the measurement on the qubit limiting its readout fidelity.

Abstract No: C-19

Some recent works of the computational materials science group

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Abstract:

In this poster we present some of our recent works focused on finding an unbiased localized description of electrons in matter in the ground state leading to effective partitioning of electrons among atoms and bonds.

We are a computational materials science group exploring low-dimensional materials, namely, quasi 1D or 2D self-assemblies of p block element, in search of new paradigms of tunable electronic, magnetic, topological, catalytic, and quantum transport properties.

Our search motivated us further to evolve inexpensive methods to perform accurate computation of the ground and excited states in experimentally realizable length-scales amounting to thousands of atoms.

We are on it for last few years with modest success in approaching the problem from the tight- binding (TB) route in the basis of optimally directed hybrid Wannier orbitals conceived in- house.

Refinement of the TB framework demands an accurate description of localization of electrons in matter, leading to the topic of this poster.

Abstract No: C-20

Device Physics of Unconventional Semiconductors

Kanha Ram Khator[1,♠], Satyaprasad P Senanayak[1]

1. *Nanoelectronics and Device Physics Lab, School of Physical Sciences, National Institute of Science Education and Research (NISER), Jatni, Khurda, Bhubaneswar 752050, Odisha, India*

Abstract:

Conventional inorganic semiconductors like silicon have becomes integral part of the current landscape of electronics, but their reliance on extreme processing conditions limits their adaptability for next-generation technologies, which require flexibility, high manipulation of material characteristics, and lower energy consumption. Unconventional semiconductors like polymers and materials such as metal halide perovskites, have emerged as viable alternatives as these materials offer significant advantages, both in terms of processing and applicability. They require significantly lower energy consumption, less specialized machinery, milder fabrication environments, and possess capabilities of performing at par with their inorganic counterparts and even better in certain applications.

We focus on the exploration of charge transport in these unconventional semiconductors to understand how they can be utilized for specific applications. Our work involves the fabrication and characterization of diodes, sensors, field-effect transistors, solar cells, phototransistors, and flexible devices. Our devices are capable of performing neuromorphic computing, which is considered the future of computing given the advancements in artificial intelligence and machine learning. Additionally, the sensors developed, based on these materials, demonstrate high efficiency in detecting critical substances such as nicotine, cancer biomarkers, glucose, and copper. The poster will summarize the research work being conducted in the field of unconventional semiconductors at our lab, and provide an overview of the advancements in this field.

Abstract No: C-21

Research and Development in Biophotonics at RRCAT

Khageswar Sahu[1,2] and Shovan Kumar Majumder[1,2]

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Abstract:

Translation of research from ‘Lab-to-Land’ or “Lab to clinics” is a crucial requirement for efficient healthcare management in developing countries like India. Photonics based diagnostic and therapeutic modalities offer distinct advantages in terms of being evidence-based, minimally invasive, selective, and prescriptive. We, at RRCAT, have been actively pursuing the investigations on the development and utilization of novel optical spectroscopy tools and innovative light-induced therapeutics in India, with the central objective to create novel optical technologies for advancing diagnoses and treatments of diseases/dysfunctions. Our researches on optical spectroscopy, imaging and phototherapy thus far have resulted in development of several first of its kind, point-of-care systems leading to transfer of know-how to Indian industries. For instance, Oncodiagnoscope and Oncovision are compact, portable, standalone tools for screening of populations at risk of oral cancer. Tuberculoscope is an easy-to-use, compact and portable device for rapid detection of tuberculosis. On the therapeutic front, the investigations on antibacterial photodynamic therapy have resulted in development of various do-it-yourself devices for management of infections of chronic wounds, body cavities and subsequent technology transfer. Moreover, these developed technologies can be tailored to adjust patients’ need and thus improve quality of life. Further, our basic research over the last half decade has also culminated in novel nanobiophotonics based diagnostics and single cell based chemical, biomechanical finger printing approaches. This poster provides a snapshot of the various activities in frontier areas of biophotonics, being carried out at RRCAT.

Abstract No: C-22

Science Using MACE Telescope

Krishna Kumar Singh* (On behalf of MACE Team)

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Abstract:

MACE (Major Atmospheric Cherenkov Experiment) is an indigenously developed state-of-the- art gamma ray telescope based on the imaging atmospheric Cherenkov technique. It is situated at an altitude of ~ 4.3km above mean sea level at Hanle- a high-altitude astronomical site in the UT of Ladakh. The MACE telescope has been operational since 2021 after its first light from the standard candle Crab Nebula. Equipped with a large light collector of 21m diameter and 25m focal length, MACE has the distinction of being the largest gamma-ray telescope in Asia and third largest in the World. It has capability of probing the violent non-thermal phenomena in the energy range of 20 GeV to 5 TeV in the Galactic and Extragalactic Universe with very high flux sensitivity. It has been able to detect several very high energy transient phenomena associated with the giant flaring activities in the Active Galactic Nuclei. Thus, the MACE telescope is emerging as a unique national facility for very high energy gamma-ray astronomy and multi-disciplinary front-line research at the interface of high energy astrophysics, astroparticle physics and cosmology in India.

Abstract No: C-23

Indigenous development of ultrafast and ultrasensitive humidity and temperature sensors using microcantilevers

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Abstract:

Microcantilevers (MCs) have proven to be highly sensitive, label free and portable transducer platforms for chemical and biological sensing applications. Primary advantage of MCs lies in their exceptional sensitivity, enabling the detection of cantilever motion with sub-nanometer precision. At IGCAR, MCs are investigated for ultrafast relative humidity (RH) and ultrasensitive temperature sensing applications. SiO_2 MCs of various dimensions were fabricated using direct laser writer and wet chemical etching methods and were tested for RH sensitivity. It is shown that introducing micropatterns on the MC surface enhances RH sensitivity by two orders of magnitude. Using these devices, real time monitoring of RH variation during human breathing cycles is demonstrated (response time < 1s). Additionally, the adsorption kinetics of water molecules on hydrophilic Si MC surfaces was studied by frequency shift measurements which revealed three distinctive slopes indicating variation in the molecular configuration of water molecules with increasing RH, as predicted by spectroscopic techniques.

For temperature sensing applications, bimaterial MCs were developed and their performance was tested. Photo-induced deflection measurements on these devices showed a maximum temperature sensitivity of ~ 23 mK/nm and an optimal noise equivalent power of 38 pW/√Hz (response time ~ 1 ms). Furthermore, bimaterial micro-mechanical devices composed of MoS_2 and SiO_2 were fabricated and were used for the first time to estimate the Young's modulus, strain, and thermal expansion coefficient of MoS_2 multilayers.

Abstract No: C-24

Exploring the Interior of Earth Using Atmospheric Neutrino Oscillations at IceCube DeepCore

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Abstract:

The discovery of a non-zero value for θ13 has opened exciting opportunities for probing the Earth's matter effects within the framework of three-flavor neutrino oscillations. This phenomenon depends on the energy of the neutrinos and the density distribution of electrons they encounter during propagation. The resulting oscillation patterns are influenced by both the total amount of matter and its spatial distribution. As neutrinos travel through Earth, they encode information about the densities they traverse. Our study demonstrates that the IceCube DeepCore can observe these matter effects in atmospheric neutrino oscillations by rejecting vacuum oscillation solutions and favoring scenarios consistent with the Preliminary Reference Earth Model (PREM). We show that the IceCube DeepCore can exploit these Earth's matter effects to differentiate between a homogeneous density profile and a layered structure. In this poster, we present the sensitivity results using 9.3 years of IceCube DeepCore data to illustrate how effectively DeepCore can reject vacuum oscillations and the homogeneous matter density hypothesis.

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Abstract No: C-25

CMS Outer Tracker Module Production and Integration at NISER

Kuldeep Kumar Pal[1♠], Rahul Kumar Agrawal[1], Seema Bahinipati[2], Ayaskanta Das[1], Suchandra Dutta[3], Balram Gauda[2], Aruna Kumar Nayak[4], Samarendra Nayak[2], Sidhartha Sahu[4], Subir Sarkar[3], Sneh Suchi[1], Sanjay Kumar Swain[1], Sriniwas Pradhan[1] & Prolay Mal[1*]

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Abstract:

Compact Muon Solenoid (CMS) is one of the major detectors at the Large Hadron Collider (LHC) with a goal to look for new physics beyond the Standard Model. The High Luminosity LHC (HL-LHC) operations era (2029 onwards) exposes several would challenges including the enhanced interaction rates up to 200 proton-proton collisions per bunch crossing. To cope with such a high radiation environment the CMS Outer Tracker (OT) would be upgraded with more granular silicon-based pixel-strip (PS) and strip-strip (2S) detector modules having track triggering capabilities. The 2S modules each consisting 4064 readout channels include several technological marvels -- radiation hard sub-micron level ASICs, high granularity silicon strip sensors, high-speed optical data transmitters, etc. The multi-stage manual assembly procedure for 2S modules, along with its quality control (QC) checks involve several state-of-the-art machineries like high-precision glue-dispenser, high-resolution optical metrology, and automatic ultrasonic wire-bonder. At NISER, a large number of 2S modules are being assembled, and the electronic noise characterization for each module is performed at 20^0C and -35^0C. The modules are subsequently integrated into the larger mechanical structures, called ladders, and further readout test and temperature-cycling of the ladders are to be performed before being shipped to CERN for commissioning.

Abstract No: C-26

First Level Calorimeter Trigger for CMS Experiment at HL-LHC

Mandakini Ravindra Patil♠*, Kajari Mazumdar, Aravind Sugunan, Abhijeet Ghodgaonkar, Pranav Govekar, Mangesh Kolwalkar and Pramod Pathare

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Abstract:

In about 5 years' time the LHC machine will start delivering proton-on-proton collisions with a very high instantaneous luminosity (HL-LHC- 5 to 7.5 × 10^{34} cm^{-2} s^{-1}), with the average number of collisions of about 200 during a single bunch crossing. Hence the interesting events get embedded in the debris of this so-called pile up. This poses a big challenge, leading to upgrades of the subsystems including the trigger using high end FPGAs and smarter algorithms to mitigate it. The CMS experiment has revamped its Level L1 trigger structure and so the main trigger board (Advanced Processor APx) deploys high-end FPGAs (Virtex Ultrascale+ VU13P), with the modular Advanced Telecommunication Architecture (ATCA) standard. Our group is responsible for the quality control of two of the crucial and complex mezzanine boards ESM and IPMC, fabricated by the Indian industry. One of these 2 boards (IPMC) is ultra-thin (1□0.1mm) and has edge-connector with 244 gold contact pads having a pitch of 0.6mm, inter-pad gap of 0.15mm. The procedure for validating these boards and the tools have been developed and designed in-house. This poster will present the highlights of the quality control methodology, challenges overcome in the Indian Industry and the trigger algorithm for the HF region, developed in TIFR.

Abstract No: C-27

Manufacturing, handling and commissioning experience of large size and slender equipment of Prototype Fast Breeder Reactor

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Bharatiya Nabhikiya Vidyut Nigam Limited (BHAVINI) Prototype Fast Breeder Reactor (PFBR) Project

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Abstract:

Prototype Fast Breeder Reactor (PFBR) is 500MWe pool type, sodium cooled fast reactor. PFBR consists of Primary Sodium Circuit (PSC), Secondary Sodium Circuits (SSCs), Safety Grade Decay Heat Removal Circuits (SGDHRCs) and a Steam-Water Circuit (SWC). The PSC removes the nuclear heat generated in the core and transfers it to the SSCs through Intermediate Heat Exchangers (IHXs). The SSCs transfers the heat to SWC through Steam Generators (SGs). PFBR is made of thin walled, over dimensional and slender equipment. Various controls and quality measures were ensured during the manufacture, handling, erection and commissioning of PFBR equipment. The design and specification requirements were met. In this paper, the experience gained during the manufacturing, erection and commissioning of large size equipment of PFBR is summarized.

Abstract No: C-28

Infrared Astronomical Cameras and Instrumentation at TIFR, Mumbai

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Abstract:

We present an overview of near-infrared (NIR) astronomical cameras developed by the Infrared astronomy group, TIFR. These cameras have been commissioned and used at various observatories in India (e.g. IGO, IUCAA, Pune; MIRO, PRL, Mt Abu; HCT, IIA, Hanle, Ladakh and DOT, ARIES, Devasthal, Uttarakhand). TANSPEC camera offers a broad coverage from optical to NIR with simultaneous imaging and spectroscopy, whereas TIRCAM2 infrared imaging camera covers extended infrared wavelength up to ~3.7 micron. Both these cameras are commissioned at India's largest 3.6-meter Devasthal optical telescope near Nainital, Uttarakhand. TIRSPEC NIR imager and spectrometer was commissioned at 2-meter HCT, Hanle, highest observatory at Indian Astronomical Observatory, Hanle, Ladakh, and has been upgraded with a new H1RG detector recently. Along with above completed projects, multi-slit infrared camera spectrometers such as TA-MOONS and MOIS are in the development stages. Balloon-borne astronomy programme is performed using our own 100 cm telescope flown to ~30 km stratospheric altitude from the TIFR Balloon Facility, Hyderabad. Development of the IRSIS project, which is a small satellite infrared telescope for space-borne platforms, is also in the pipeline. In instrumentation, prototype FPA controllers are developed successfully and further development is in progress.

Abstract No: C-29

Physics Study with Indus 1 and Indus 2 Beamlines

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Abstract:

Synchrotron radiation sources are indispensable components of a modern nation aspiring to embrace newer technologies. Such photon sources help in investigation of materials encompassing all aspects of current civilizational needs including materials required in healthcare, materials for energy storage and generation, for mitigating industrial pollution and climate change, for larger storage devices and also for advanced quantum technologies. Like every modern nation, India has its own synchrotron radiation sources viz., 450 MeV Indus-1 and 2.5 GeV Indus-2 which are being operational since last few decades at Raja Ramanna Centre for Advanced Technology, Indore. The beamlines built by scientists and engineers of the Department of Atomic Energy (DAE) at the synchrotron sources are being used by large number of users both from DAE and non-DAE laboratories, academia and also by Indian industries. Bhabha Atomic Research Centre (BARC) has played a key role in this endeavour. In particular, from the very early days, Physics Group of Bhabha Atomic Research Centre (BARC), had been actively involved in the design, development, operation, maintenance and utilisations of various beamlines in these two synchrotron sources. So far, Physics Group of BARC has built 5 beamlines at Indus-1 source and 8 beamlines at Indus-2 source. These beamlines are routinely being used for investigating various physics aspect of technologically important samples encompassing all areas of science and technologies including chemical, material, earth and environmental sciences. The beamlines cover a wide measurement range spanning from long range to local structural properties including properties in mesoscopic length scales, electronic structure, spectroscopic information at atomic and molecular levels, imaging and crystallographic information of proteins and macromolecules.

Abstract No: C-30

Tribological studies on FBR Materials

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Abstract:

Relative motion inevitably occurs in several fast reactor components. This relative motion can induce wear and tear, thereby reducing the component service life and impacting efficiency. To predict the service life of these components, it is essential to understand the tribological behaviour of mating material pairs. This work highlights tribological properties of three material pairs used in the Prototype Fast Breeder Reactor (PFBR): (i) alloy D9 against itself (in reactor core), (ii) polytetrafluoroethylene (PTFE) against hardened steel (for periscope lamp holder), and

(iii) fluoroelastomer (FKM) against SS 304L (for ISI vehicle wheel lining).

Self-mating of alloy D9is sensitive to the imposed load and operating temperature. The wear mechanism of alloy D9 is predominately adhesive at 500°C and 550°C, whereas room- temperature wear is primarily abrasive. At room temperature, the increased wear is accompanied by low coefficient of friction (CoF<1). Low CoF is inherent to the PTFE-steel material pair; however tribological evaluation shows that this material pair is qualified for operating temperature of 150ºC. In addition to environmental factors such as temperature, intrinsic material properties influence the tribological characteristics of some material pairs, such as the fluoroelastomer (FKM)-SS304 L pair. Suitable reinforcement of FKM is seen to reduce the wear damage; carbon-reinforced FKM is found to be superior to silica-reinforced FKM. The tribological behavior of three different materials pairs used in PFBR will be presented.

Abstract No: C-31

Development of Fiber Bragg gratings, Fiber Sensors and their Deployment in Nuclear and Industrial Environment

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Abstract:

The temperature, strain, load and fire sensing in the harsh environment associated with nuclear

and industrial facility is a challenging task. Various optical fiber sensors (OFSs), including radiation-resistant fiber Bragg grating (FBG) sensors, are increasingly being utilized for instrumentation in future nuclear power plants and smelting furnaces. These sensors must endure extreme conditions, including high temperatures, radiation, electromagnetic interference (EMI), and high microwave power. At RRCAT, fiber optic temperature sensors have been developed for single-point, multi-point, and distributed sensing applications. The single point and multi-point temperature sensor upto 900 ^{o}C, have been developed using different variant of fiber Bragg gratings (FBGs). These FBGs are fabricated using indigenously developed high beam quality and high repetition rate (~5.5 kHz) 255 nm UV beam generated from frequency doubled copper vapour laser (CVL). This facility is made available to Indian industries through Incubation Centre, RRCAT. FBGs based single point as well as multipoint temperature sensors are successfully developed and deployed in temperature monitoring of dipole magnet vacuum chamber wall in Indus-2 (synchrotron radiation source), temperature monitoring in fuel recycling chamber of Advanced Fuel Fabrication Facility, BARC, Tarapur, multi-point temperature monitoring of inactive induction furnace at Area-33 WIP BARC, temperature monitoring of Tundish at Tata Steel, Jamshedpur. In addition to temperature sensing, FBG-based load sensors have been developed and deployed for weight monitoring of cesium pencils at Area-33 WIP, BARC. The Wheel Impact Load Detection (WILD) system, developed in collaboration with Lab- 2-Market, an IISc Bengaluru startup, improves railway safety by detecting wheel impacts. The distributed optical fiber temperature sensor named ‘Agni-rakshak’ for fire detection system based of Raman Optical fiber distributed temperature system are successfully developed and deployed. The technology of Agni-rakshak is transferred to six Indian Industry and startup.

Abstract No: C-32

Growth and Applications of Quantum materials

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Abstract:

This poster will discuss some of the work being carried out in CEBS related to growth, characterization, and application of quantum materials - single crystal diamond, nano-diamonds, and superconducting thin films:

The growth of single crystal diamond (SCD) at wafer scale (□25 mm × 25 mm) opens an avenue for next generation quantum electronic devices. Diamond-based color centres, such as Nitrogen-vacancy (NV^-), Silicon-vacancy (SiV^-), and Germanium-vacancy (GeV-) are emerging as quantum emitters in solid-state system for quantum communication and sensing applications. The NV^- centres in nitrogen-controlled SCD exhibit single photon emission behaviours. Moreover, the splitting of optically detected magnetic resonances of NV^- centres reveal the atomic level stress in the sample.

A material science goal based on laser-induced plasma is to use the Pulsed Laser Ablation in Liquid (PLAL) technique to synthesize fluorescent carbon nano-diamonds/nano- dots from bulk solid carbon precursors. Preliminary experimental results of nanosecond laser ablation of graphite rod/activated carbon immersed in water and the characterization of microwave plasma-purified ablated sample by confocal fluorescence imaging and Raman spectroscopy hints at the generation of carbon particles with a nano-diamond (sp3) structure like shock-driven detonation nano-diamonds.

Since the past couple of decades there has been a renewed interest in 2D superconductors, wherein, reduced dimensionality and quantum fluctuations significantly influence superconducting behavior, leading to interesting phenomena such as the superconductor-insulator transition (SIT), the Berezinskii-Kosterlitz-Thouless (BKT) transition etc. Through studies on different superconducting thin films, understanding the effect of thickness, disorder, geometry on superconducting properties will be presented, primarily focusing on the study of topological phase transitions in nano-porous films.

Abstract No: C-33

Radiation Damage in Nuclear materials using Ion Beams - Developments & Experiments

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Abstract:

The structural materials in future advanced nuclear systems, such as Gen IV and small modular reactors, are expected to handle higher temperatures and doses than those in current reactors. For the near-term development of these advanced reactors, it is crucial to establish test facilities where the radiation response of the potential structural materials can be rapidly assessed. An effective approach involves utilizing ion irradiation to reproduce the microstructures that occur during neutron irradiation in a reactor. For several decades, IGCAR has been running a comprehensive program to study radiation damages in nuclear materials using ion irradiation. Several facilities such as dual-ion irradiation, in-situ irradiation/imaging, ionoluminescence, and high-resolution RBS facilities are developed for evaluating defect evolution and diffusion behavior. Recent studies in metals and alloys include texture development and void swelling in nanocrystalline Ni, precipitate stability of Ti-ODS and Zr-ODS alloys, and evaluation of defect signatures in dispersoids of ODS alloys. Alongside, comprehensive studies of phase transformation and the role of transmutant gases in a host of nuclear ceramics, ThO_2, Gd_2O_3, and ZrO_2 are pursued. Besides, defect recovery in SiC by the ionization-induced defect annealing process is demonstrated. The poster provides a concise overview of the developments and studies mentioned above.

Abstract No: C-34

Exploring ultrafast dynamics in quantum materials

Payel Shee, Amit Haldar, Arpita Dutta, Kshitij V Goyal, Nainish Tickoo, Swayam Panda, Swosti Prakash Sarangi, Shovon Pal*

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Abstract:

Quantum materials are characterized by the collective interaction of numerous electrons through their charge, spin, orbital, and lattice excitations. The intricate interplay between these excitations gives rise to fascinating phenomena like the Kondo effect [1], collective magnon modes [2], ferroelectricity [3], and superconductivity [4]. Understanding the ground state, which is dominated by strong correlation effects, is a challenging task due to the multi-particle nature of these materials. However, the study of the equilibrium and non-equilibrium behaviour of the ground state provides insights into the microscopic processes that stabilize such strongly correlated states. In recent years, the advancement in spectroscopic research have propelled the strong correlation dynamics into a new and influential branch of condensed-matter research. The development of THz time-domain spectroscopy (THz-TDS) has revolutionized fundamental THz research by enabling resonant excitation and detection of electronic states in any quantum materials with characteristic energies in the low THz photon energies (approximately 4 meV at 1 THz). Moreover, the advancement of various techniques, including optical- pump THz-probe and THz-pump THz-probe spectroscopy, has provided opportunities to investigate novel types of non-equilibrium phenomena and nonlinear effects in different quantum materials. Intense THz pulses also bear the potential to drive the resonant couplings between various fundamental excitations in these material systems.

Abstract No: C-35

Experiences on Remote Chemical Plugging of Leak in Biological Shield Cooling System of PFBR

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Abstract:

Prototype Fast Breeder Reactor (PFBR) is sodium cooled Fast Breeder Reactor. The Reactor Assembly is housed in a concrete Reactor Vault (RV) lined with carbon steel. Biological Shield Cooling (BSC) system cools the concrete of RV to maintain the concrete temperature. An incident of leak was observed within the concrete embedded Bottom Shield during routine operation. The leak was arrested by remote leak sealing. This method works on the principle that when a certain sealant mix is introduced into the defective pipe and by applying its working pressure, the sealant is forced to flow through defects where it swells to staunch the flow and eventually seals the defect. Established the procedures and several samples of Bentonite Clay were tested for chemical composition by using X-ray diffraction technique. Sealant Tested for miscibility with water and viscosity profile after mixing with water. This revealed that sodium-based Bentonite chemical sealant can be used for remote leak sealing in carbon steel embedded piping up to 300μm leak. This poster brings out the experiences gained in remote Plugging of Leak in BSC system of PFBR and describes the scope for future work on Remote Chemical Plugging of leak in embedded pipe systems.

Abstract No: C-36

Data logger and Cloud Controller and Monitor

Shradhha Suman Panigrahi, Sanjib Sahu, Pradip Sahu

Institute of Physics, Bhubaneswar

Abstract:

The Detector laboratory is always maintained with clean and controlled environment. An effort is made here to develop a microcontroller-based system to monitor the Temperature, Pressure, Humidity and Particle concentration of the laboratory environment. The monitoring system is designed with a local display and interfaced with computer using LabVIEW for data logging also the display and control facility available through the IoT cloud control.

There are five parameters, namely, temperature, humidity, barometric air pressure, particulate matter 1.0 and 2.5 number concentrations. We have used advanced sensors for the same and the latest MCU board from Arduino which is Arduino Uno R4 WiFi (Renesas ARM Cortex M4). It has inbuilt bluetooth and WiFi controller. Data is read and sent to the cloud control software, Arduino IoT Cloud. The data from the DAQ has been inculcated and T /P correction and gain have been observed using the gas-filled detector in HED Lab at IoPB. This system allows real-time data logging and monitoring in the dashboard of Arduino IoT Cloud.

Abstract No: C-37

Motion of anisotropic particles settling in turbulence

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Abstract:

We examine the dynamics of sub-Kolmogorov anisotropic particles sedimenting through turbulence. Instances of suspensions of anisotropic particles are ubiquitous in nature, for example, Cirrus clouds in the atmosphere that are composed of ice crystals. The orientation dynamics of these ice crystals plays a crucial role in the planetary greenhouse effect. We perform three-dimensional direct numerical simulations (DNS) of such crystals, modelled as spheroids, settling through a homogeneous isotropic turbulent flow field, including the effects of gravity on both the particle translational and rotational degrees of freedom. Particle orientation distributions are obtained over a wide range of spheroid aspect ratios, Stokes numbers and particle settling velocities. For all the cases examined, distributions peak at the broadside-on (to gravity) orientation and depart significantly from Gaussianity. These DNS results have been compared against theoretical predictions in the inertialess rapid-settling limit, when a particle sediment through a Kolmogorov eddy much faster than the latter decorrelates. The DNS results deviate from theory for Stokes numbers of order unity due to a spatially inhomogeneous particle concentration field resulting from a preferential sweeping effect. This spatial inhomogeneity of the concentration field is characterized via a correlation dimension $\boldsymbol{D_2}$ allowing an estimate of clustering effects down to the Kolmogorov scale; $\boldsymbol{D_2}$ is found to be shape sensitive, with the degree of clustering being more for extreme shapes. We also show that because of gravity, extreme-shaped spheroids approach each other faster for St $\leq$ 0.4 as compared to the spherical particles. These results on the clustering of particles and their relative velocities can be used to model collision kernels for settling anisotropic particles.

Abstract No: C-38

Superconducting cavity activities and development of RF technology at RRCAT

Praveen Mohania♠*, Vikas Jain, S.Raghavendra, Adarsh Pratap Singh, Ashish Mahawar, Alok Gupta, Ramesh Kumar,Akhilesh Jain, Sanjay Chouksey, Mahendra Lad

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Abstract:

DAE has a long-term program on developing high intensity 1 GeV Continuous Wave (CW) proton accelerator (linac, average power >10 MW) for Accelerator Driven Subcritical System (ADSS). Additionally, DAE is contributing to the Proton Improvement Program-II (PIP-II) at Fermilab, USA, under the Indian Institutions Fermilab Collaboration (IIFC). Under both these programs RRCAT has set up critical infrastructure for the development of Super conducting RF (SCRF) cavities and RF technologies.

RRCAT is involved in development of 650 MHz (β=0.92) five-cell Niobium SCRF cavities since last decade and has developed an infrastructure for in-house fabrication, surface preparation and RF qualification of both bare and dressed (with jacket and high-power coupler) cavities. Also, for RF qualification of 'bare' and 'dressed' cavities at 2K, two test stands namely, the Vertical Test Stand (VTS) and the Horizontal Test Stand (HTS) are operational.

RRCAT has made considerable effort in developing RF technologies like high power SSA, high power Circulator, digital LLRF and transmission line components like combiners/dividers, directional coupler, RF loads etc. Most of these are import substitute critical RF technologies needed in large numbers for DAE mega science projects. Also, SSAs and SCRF cavities are deliverables to Fermilab USA under IIFC construction phase.

Abstract No: C-39

Beyond Conventional Lithium-Ion Batteries

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Abstract:

Lithium-ion batteries revolutionized the digital world with portable devices, lightweight powering sources etc. but, a huge demand for storage systems competent with that of conventional fossil fuels is on. Dearth of fossil fuels along with their huge carbon footprint make the people seek for alternatives and new battery chemistries and materials are in search to address. Our laboratory for the past 9 years is looking in to these aspects and the following themes of research is in progress:

i. Developing safer and affordable batteries to the Indian subcontinent.
ii. Developing methods for bringing safety and high energy density to lithium batteries.
iii. Direct charging of batteries using sunlight.

The poster will be showcasing our recent efforts on zinc (Zn) - air batteries, which are safer and affordable but need research to make them matured enough for practical usage. These batteries can find applications from portable low powered devices to micro-grids; leaving issues such as cyclability, self-discharge etc. for further addressing with fundamental research. Not many labs are focussing on these aspects though such systems can meet cost-effectiveness and high energy density requirements. Sodium ion batteries are another interesting candidate of our interest where active pursuit is in progress.

Existing lithium-based batteries have issues related to safety though they are one of the very effective battery chemistries adaptable to different industries. Our laboratory is actively pursuing to address these issues with the development of cost-effective separators, surface modification etc. The poster will be highlighting some of these aspects too.

Can we charge a battery using light? A search for such a possibility led us in inventing stable solar batteries with unconventional heterostructured based cathodes. Our past few years of research indicates the potential of such a direct solar rechargeable battery without the intervention of solar cells and the findings also lead to several interesting fundamental breakthroughs including the delaying the phase transition of semiconductors. Some of these findings will be also highlighted in the poster.

Abstract No: C-40

Inertia drives concentration-wave instability in swimmer suspensions

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Abstract:

We discover an instability mechanism in suspensions of self-propelled particles that does not involve active stress. Instead, it is driven by a subtle interplay of inertia, swimmer motility, and concentration fluctuations, through a crucial time lag between the velocity and the concentration field. The resulting time-persistent state seen in our high-resolution numerical simulations consists of self-sustained waves of concentration and orientation, transiting from regular oscillations to wave turbulence. We analyze the statistical features of this active turbulence, including an intriguing connection to the Batchelor spectrum of passive scalars.

Abstract No: C-41

Single Crystals and Radiation Detectors

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Abstract:

Technology to grow single crystals is complex and multidisciplinary. Directly or indirectly most of the advance and strategic technologies like laser, semiconductor, and detectors are based on single crystals. In DAE, radiation detectors are essential for operation of reactors, fuel processing and radiation monitoring. Technical Physics Division of Physics Group, BARC has developed Czochralski and Bridgman crystal growth process for oxides, halides and semiconductors including instrumentation along with the technology for fabrication various kind of radiation detectors in an effort to cater DAE's requirement and make India self-reliant in advanced technologies.

Abstract No: C-42

A Comparative Study of Structural Materials Damage using NRT and Athermal-Recombination Model for FBR

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Abstract:

Estimation of irradiation damage of structural materials is one of the important parameters which determines fuel residence time, refuelling scheme and life time of reactors. Radiation damage can change mechanical properties which include ductility, tensile strength, embrittlement, cracks, swelling, elongation irradiation creep, phase transformation, segregation of alloys, thermal conductivity and thermal expansion that can affect lifetimes. It is desirable to have a standardized parameter to quantify radiation damage exposure that would provide a common basis for comparison of data obtained under different irradiation spectrum. Currently accepted standard parameter for radiation effect is the number of displacements per atom (dpa) using the Norgett Robinson-Torrens (NRT) model. Recently, a modified NRT model called the athermal recombination corrected dpa (arc-dpa) has been proposed. It addresses a well-known issue of NRT, namely, overestimation of the number of stable defects generated by high energy displacement cascades. The arc-dpa model is based on experimental studies and computer simulations, which indicates that significant defect recombination takes place during the cascade cool-down phase leading to reduced numbers of remaining stable defects. In this work a comparative study of dpa estimation for iron has been done using NRT and arc-dpa data. It was found that the dpa calculated using arc-dpa data is 61 to 66 % lesser than dpa computed using NRT data at grid plate and clad respectively.

Abstract No: C-43

Celestial Holography: An Attempt to Understand Quantum Gravity in Asymptotically Flat Spacetime

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Abstract:

Celestial holography aims to compute the S-matrix of quantum theory of gravity in (3+1) D asymptotically flat spacetime in terms of the correlators of a 2D (Celestial) CFT that lives on the celestial sphere at null infinity. The boundary CFT has some striking features which make it different from conventional 2D CFT, hence the name 'Celestial CFT'. Our research primarily focuses on exploring the symmetries of the celestial amplitudes and its implications. Celestial amplitudes admit soft and collinear factorizations. Soft factorizations lead to the Ward identities of the asymptotic symmetries and the collinear factorization helps to compute the celestial OPEs between two primary operators. It was recently discovered that asymptotic symmetry algebra for gravity in AFS is the infinite dimensional wedge subalgebra of $w_{1+\infty}$ and for the gluons it is the S algebra. These algebras admit the presence of null states in them, our research also focuses on finding these null states and showing how they constrain the boundary theories. Our group has recently classified all the w and S-invariant OPEs on the celestial sphere using the null states of these algebras. Our research is also aimed at exploring other facets of celestial holography in future.

Abstract No: C-44

E-Beam Technology for Sterilization of Medical Devices – A Step towards Atmanirbhar Bharat

Rakesh Kumar Soni ♠, Pankaj Kumar, Rajeshwar Singh Sandha, Vijaypal Verma, Ajay Kumar, Divya Purohit, R S Choudhary, Makwana Karan, Jishnu Dwivedi, V C Petwal*

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Abstract:

Electron Beam Radiation Facility (ARPF) set up by RRCAT at Indore has reached a new milestone for electron beam sterilization of 4.5 million regulated medical devices since year 2021 and 3 million devices in last one year. The facility has a reliable operation and being operated in conformance with Medical Device Rules (MDR) 2017 under license from Food & Drugs Administration (FDA) MP state for Risk Class-A & Risk Class-B medical devices. E-beam sterilization process has been developed and validated for different type of medical devices such as silvasorb hydrogel dressing, cotton gaugze pieces, blood collection tubes, different types of surgical gloves, hypodermic syringes, IV cannula, collagen sheets, rubber stopper and PP vials. ARPF is the first E-beam facility in the country operating under strict quality requirements of ISO certification and regulatory licenses.

The facility is also utilized for commercial irradiation of colour modification of gems and demonstrated new application areas as new crop variety development, phytosanitary treatment of agricultural products, exotic color development in ornamental flowers, radiation damage studies for space applications, modification of properties of semiconductor components etc.

RRCAT has deployed a 10 MeV, 10 kW linac for Technological Scale Performance Studies in Industrial Environment. RRCAT has also developed a 10 MeV, 15 kW food irradiation Linac with energy filtering system to remove electrons above 10 MeV.

This technology is also useful for other applications like radiotherapy, industrial radiography of thick components, neutron radiography, cargo scanning, medical isotope production etc. RRCAT is working for industrial manufacturing of these linacs by Indian Industries.

Abstract No: C-45

Topological Magnetism and Skyrmion Dynamics in Advanced Magnetic Materials: Insights into Magneto-Transport and Spintronic Applications

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Abstract:

Laboratory of Novel Magnetism and Spintronics (NMS- Lab) at NISER Bhubaneswar, an institute under the Department of Atomic Energy, Government of India, delves into the intricate relationship between magnetic order and topology—an area of immense promise in both fundamental and applied physics. Our research primarily focuses on exploring the skyrmion phase and its profound impact on topology and magneto-transport properties in advanced magnetic materials like Mn_3Sn, Mn1.4Pt Sn, and Mn_4Ga_2Sn, using self-grown single crystals and single crystalline devices crafted out of a single polycrystalline grain.

We employ state-of-the-art fabrication techniques such as Electron Backscatter Diffraction (EBSD), Focused Ion Beam (FIB) milling, and Lorentz Transmission Electron Microscopy (LTEM) to prepare and study single-crystal devices from both single and polycrystalline samples, ensuring precision and high-quality analysis.

A major aspect of our work involves investigating the stabilization and manipulation of skyrmions using temperature and magnetic field variations, opening new frontiers for potential applications in spintronic technologies. We also study the anomalous Hall effect, particularly in Weyl semimetals and rare-earth metals, with a focus on understanding its electronic band structure, temperature, and pressure dependence.

Abstract No: C-46

Convergence of Gradient Expansion in the RTA Approximation

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Abstract:

A formal integral solution to the 3+1 D Boltzmann Equation in relaxation time approximation is obtained. The gradient series obtained from this integral solution contains exponentially decaying non-hydrodynamic terms. It is shown that this gradient expansion can have a finite radius of convergence under certain assumptions of analyticity. We then argue that, in the relaxation time model, proximity to local thermal equilibrium is not necessary for the system to be described by hydrodynamic equations.

Abstract No: C-47

Radiation Damage Studies on Nuclear Reactor Core Structural Materials using Positron Annihilation Spectroscopy

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Abstract:

Positron annihilation spectroscopy (PAS) is a versatile nuclear technique to carry out defect studies in materials with sensitivity down to monovacancies in ppm levels. PAS techniques enable the investigation of open-volume defects in materials such as vacancies, vacancy clusters, dislocations, grain boundaries, voids, and precipitates, which influence many physical and mechanical properties of the materials. Ion beam implantation is a cost-effective alternative to simulate the neutron-induced radiation damage in reactor materials without any induced radioactivity and with good control over the irradiation parameters. The advent of slow positron beams enabled the non-destructive depth-resolved defect studies in ion-implanted materials with atomistic resolution. Radiation damage studies on different potential materials of fission and fusion reactors have been extensively carried out in our lab using in-house-made PAS techniques during the past couple of decades. Some of the materials investigated are SS316, alloy D9, Indian Reduced Activation Ferritic/Martensisitc (INRAFM) steel, Vanadium based alloys, high-entropy alloys, ODS steels, Tungsten, etc. The presentation consists of some of the important results from our recent radiation damage studies on the reactor core materials using ion beam implantation and positron annihilation spectroscopy.

Abstract No: C-48

Precision measurements of neutrino oscillation parameters exploiting the complementarity between DUNE and T2HK

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Abstract:

An improved precision measurement of Δm^2_{31} and θ_{23} is inevitable to

estimate the Earth's matter effect in long-baseline experiments which plays a crucial role in addressing the issue of neutrino mass ordering and to measure the value of CP phase in 3ν framework. After revisiting the results from the current experiments and discussing the near-future sensitivities from IceCube Upgrade and KM3NeT/ORCA, we study the improvements in the precision of 2-3 oscillation parameters that the next-generation

experiments, DUNE and T2HK, can bring either in isolation or combination. We highlight the relevance of the possible complementarity between DUNE and T2HK in determining the sensitivity towards the deviation from maximal mixing of θ_{23}, excluding the wrong octant solution of θ_{23}, and obtaining high precision on 2-3 oscillation parameters, as compared to their individual performances. We observe that for the current best-fit values of the oscillation parameters and assuming normal mass ordering (NMO), DUNE + T2HK can establish the non-maximal θ_{23} and exclude the wrong octant solution of θ_{23} at around 7σ C.L. with their nominal exposures. We find that DUNE + T2HK can improve the current

relative 1σ precision on $\sin^2\theta_{23}$ (Δm^2_{31}) by a factor of 7 (5) assuming NMO. Also, we notice that with less than half of their nominal exposures, DUNE + T2HK can achieve the sensitivities that are expected from these individual experiments using their full exposures. We also portray how the synergy between DUNE and T2HK can provide better constraints on ($\sin^2\theta_{23}$ - δ_{CP}) plane as compared to their individual reach.

Abstract No: C-49

Exploring Magnetism and Superconductivity through High-Quality Single Crystals

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Abstract:

The study of magnetism and superconductivity has been a major focus in the condensed matter physics research at TIFR. Several new rare-earth based intermetallic magnetic compounds have been discovered, with the notable discovery of superconductivity in the borocarbide system. More recently, the growth of high-quality single crystals of elemental bismuth has led to the discovery of superconductivity in this low-carrier system at 0.53 mK, which fuelled both theoretical and experimental investigations further. The observed superconductivity in Bi, owe much to the exceptional quality of the single crystals. To support such research, we have established a state-of- the-art single crystal growth facility that employs various crystal growth techniques like high-temperature solution growth, Czochralski growth, Bridgman growth, Vapor transport, and Floating Zone growth. Single crystal growth allows for the study of anisotropic physical properties, which requires careful alignment along the principal crystallographic directions. This is achieved through Laue diffraction, followed by precise cutting with a spark erosion machine. In this presentation, we will highlight the capabilities of our crystal growth facility and showcase some of the significant results enabled by these high-quality single crystals.

Abstract No: C-50

Reaching Curzon-Ahlborn limit in linear response and Whitney limit in nonlinear response in edge mode quantum thermoelectrics and refrigeration

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Abstract:

Quantum heat engines and quantum refrigerators are proposed in three-terminal quantum Hall (QH) and quantum spin Hall (QSH) setups with a voltage-temperature probe in linear and non-linear transport regimes. In the linear response regime, we find that efficiency at maximum power approaches the Curzon-Ahlborn limit in both QH and QSH setups. Similarly, in non-linear response, we find that efficiency at maximum power reaches the Whitney bounds. For the first time, we see that the thermoelectric efficiency limits in linear and nonlinear transport regimes are achieved using quantum point contacts in the same setup.

Abstract No: C-51

Development of a 256-pixel SiPM based Camera for a 4-m Class Imaging Atmospheric Cherenkov Telescope

Sandeep Duhan ♠*, S.S. Upadhya, K. S. Gothe, S. K. Rao, B.K. Nagesh, Mano Ranjan, N.K. Parmar, B.B. Singh, Abhradeep Roy, and Varsha R. Chitnis

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Abstract:

The Imaging Atmospheric Cherenkov Telescopes (IACTs) detect very-high-energy gamma- rays from celestial objects indirectly. Camera is an important component of IACTs which detects and captures the Cherenkov light pulses emitted by gamma-ray induced air showers. In last few years, there is growing interest in developing silicon photomultiplier (SiPM) based cameras for IACTs. Use of SiPMs offers several advantages over traditionally used photomultiplier tubes, including higher photon-detection efficiency, lower operating voltage, and robustness to light exposure. A 256-pixel SiPM based camera for a 4-meter class IACT is developed in-house at TIFR. The camera covers a field-of-view of ~5° with pixel resolution of 0.3°. A modular approach is followed in camera development. The 256 pixels of the camera are organised into 16 clusters of 16 pixels each. The camera pixel signals are digitized by a high-speed data acquisition system based on a switched capacitor array chip, DRS4. The camera follows a three-stage trigger system based on a combination of non-collinear nearest neighbour pixels exceeding a specified threshold within a certain time window. The camera was fully commissioned in December 2023 at the TACTIC telescope array in Mount Abu, Rajasthan. This poster presents the development of the camera, design considerations, and some performance characteristics.

Abstract No: C-52

Development of Low Dose Irradiator (LDI-1000)

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Abstract:

Low Dose Irradiators are devices which are used to deliver doses in the range of mGy or Gy to the targeted objects to achieve certain desired effect. They are used for blood irradiation, tissue graft, stem cell study, sterile insect technique, radio biology etc. Radiation doses are given in the form of ionizing radiation such as gamma rays using Cobalt-60 or Cesium-137 radio isotopes or X-rays. Currently, these low dose irradiators developed by Board of Radiation and Isotope Technology (BRIT) uses Cobalt-60 radiation source which makes the irradiator bulkier in weigh making them difficult to install at floor above the ground level. In addition, due to less half-life of Co-60 source as compared to the useful life of the machine, it requires source replenishment.

Board of Radiation & Isotope Technology (BRIT) has developed a Category-I type Low Dose Irradiator (LDI-1000) based on Cesium-137. It can house 3200Ci for Cesium-137 in the form of sealed source pencil and has an irradiation volume of 1000 ml. Cs-137 is in the form of vitrified glass matrix encapsulated in SS316L with a specific activity of 2-5 Ci/gm. The central dose rate of the irradiator is 12Gy/min with a dose uniformity ratio (DUR) of 1.2. The Irradiator consists of source housing, drawer assembly, driving unit and cabinet. Lead is used as a shielding material and SS304L is used as lead encasing material. The overall weight of the irradiator is 1.2 Ton i.e. light in weight and easy to install at any floor level in urban areas. This paper gives an overview of irradiator design features and its conformance to the regulatory requirements.

Abstract No: C-53

Harnessing Topology in Real and Momentum Space: A Multiscale Materials Modeling Approach

Sayan Banik ♠, Md Habib Ahsan, Subhadip Pradhan, Tanaya Halder & Ashis Kumar Nandy*

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Abstract:

Density Functional Theory (DFT) simulations have emerged as a powerful tool for investigating real materials' electronic, transport and magnetic properties. We employ DFT simulations to calculate electronic properties of materials ranging from bulk to surface/interface systems. A prime focus is on non-trivial states and/or interactions arising from the interplay between spin-orbit coupling and symmetry. In most cases, we study various kinds of magnetic heterostructures, particularly transition metals interfaced with substrates like semiconductors, superconductors, and heavy metals. The material design approach within electronic structure theory enables us to understand the microscopic interaction picture and extract various magnetic exchange parameters. The material parametrization is further utilized to understand the magnetic ground state properties, topological magnetism, and explore the complex dynamics of magnetic vortices driven by magnetic pulses, electric currents. In most bulk systems, we focus on topological states in momentum space and associated transport phenomena. Ab initio electronic structure studies have been further employed to establish effective low-energy model Hamiltonians, a crucial step in scanning the parameter space even at finite temperatures. To date, we have established a strong foundation in topological magnetism and its dynamics, topology in band structures, current-driven non-trivial transport and spin generation, and finite temperature effects within model Hamiltonian approaches.

Abstract No: C-54

The Indian Network for Detection of Radon Anomaly for Seismic Application (INDRA-SA)

BK Sahoo, BK Sapra, SD Kanse, JJ Gaware, DH Kumbhar, MP Ratheesh, Arshad Khan, DK Aswal Health

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Abstract:

The Indian Network for Detection of Radon Anomaly for Seismic Application (INDRA-SA) has been established to study geo-genic radon gas as a potential precursor to earthquakes in the Indian subcontinent. To facilitate this research, a network of up to 100 BhaROSA (Bhabha Radon Observatory for Seismic Application) systems has been deployed across the country. BhaROSA is a self-sustaining, solar-powered radon monitoring system, designed and developed indigenously for large-scale, long-term monitoring of radon at the soil-air interface. Each system consists of a radon accumulator, continuous radon monitor, solar panel with battery backup, secure data communication through GPRS technology, and an environmental protection enclosure.

The system locations were chosen based on factors such as terrain, proximity to major Himalayan fault lines, and the frequency of seismic activity. Most of the systems are installed along the Himalayan belt (H series), and in the Eastern (E series) and Western Ghats (W series) regions. Data from each observatory is transmitted to a central station every 15 minutes via a secure Virtual Private Network (VPN) using 3G/4G GPRS technology. Alongside this, the central station maintains a comprehensive database of earthquake events reported by national and international agencies.

The accumulated data provides valuable insights into the spatial and temporal responses of the observatories, enhancing our understanding of the complex processes involved in earthquake nucleation along fault lines and their dynamic behavior. This initiative is a significant step toward advancing earthquake predictability— a longstanding and unresolved challenge for humanity.

Abstract No: C-55

The IR-FEL at RRCAT: An Enabling Facility for Basic Sciences

Shankar Lal[1,2,a], Bhaskar Biswas[1], Sona Chandran[1,2], Shilpam Sharma[1], L.S. Sharath Chandra[1,2], R. S. Saini[1], Arvind Kumar[1], Umesh Kale[1], Ashish K. Khandelwal[1], M.K. Chattopadhyay[1,2] and K. K. Pant[1]

[1]Free Electron Laser and Utilization Section, RRCAT, Indore, 452013, India [2]Homi Bhabha National Institute, Training School Complex, Anushakti Nagar, Mumbai 400094, India

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Abstract:

RRCAT is home to three accelerator based light sources: the Synchrotron Radiation Sources (SRS) Indus 1 and Indus 2, and an Infra-Red Free Electron Laser (IR-FEL). While Indus 1 and 2 deliver broadband radiation extending from the IR to hard X-ray wavelength with tens of nanosecond long pulses, the IR-FEL complements the Indus SRS with wavelength tunable continuously from 12.5 - 50 µm and picosecond pulses. The spectral brightness of the IR-FEL is two orders of magnitude higher than that from Indus SRS at these wavelengths. Of the four user stations planned using FEL light, a facility for frequency domain spectroscopy of materials has been commissioned with provision for a sample environment with high magnetic field (7 Tesla) and low temperature (5 K). First user experiments have been successfully performed at this station. Three more user stations are expected to be commissioned by the end of 2024: (i) IR-FEL based pump-probe studies and harmonic generation, (ii) Time domain studies with a short pulse laser coupled to the IR- FEL for pump-probe experiments, and (iii) IR-FEL based irradiation experiments in Biology and Chemistry.

This poster discusses the salient features of the IR-FEL based facility developed to enable frontline experiments in basic sciences.

Abstract No: C-56

Unraveling internal structure of the Earth using atmospheric neutrino oscillations in IceCube DeepCore

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Abstract:

The information about the mass of Earth and its internal structure has been obtained mainly using gravitational measurements and seismic studies, which depend upon gravitational and electromagnetic interactions, respectively. Neutrinos provide an independent way of exploring the interior of Earth using weak interactions through Earth's matter effects in neutrino oscillations. Since these matter effects depend upon the number density of electrons, neutrino oscillations can be used to measure the amount of electrons and their distribution inside Earth. The electron number density can then be interpreted in terms of matter density inside Earth. In our study, we utilize atmospheric neutrinos at DeepCore, a densely instrumented sub-detector at the center of the IceCube Neutrino Observatory, to estimate the mass of Earth and the density of various layers inside the Earth. Further, we have also evaluated the potential enhancement in our results with the upcoming Upgrade, which is an extension of the DeepCore, with more denser instrumentation. Our investigation not only provides valuable insights into Earth's composition but also showcases how neutrino oscillations enable new perspectives in probing the fundamental properties of our planet.

Abstract No: C-57

RRCAT developed machine vision systems for precision metrology of nuclear reactor fuel, components and assemblies

Sachin Kumar Agrawal, Ayukt Kumar Pathak, Azim Uddin Siddiqui, Sumit Kushwaha, M. A. Ansari,Shradha Tiwari, P.P. Deshpande, V.P. Bhanage and S.K. Dixit

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Abstract:

Efficient operation coupled with continuous expansion of the Indian nuclear power program increases the demand for nuclear fuel fabrication and inspection across various fuel production facilities of the Department of Atomic Energy (DAE). The nuclear industry imposes stringent safety and quality control standards. Nuclear reactor fuel, components and assemblies often have complex geometries and are subjected to harsh operating conditions. A single fuel assembly consists of large number of different types of components with tight dimensional tolerance. Moreover, a nuclear reactor has variety of fuel assemblies. Traditional inspection methods, such as human based visual and dimensional inspection are based on hand operated mechanical measurements that are time-consuming, manpower, man-rem intensive and prone to human error. Moreover, highly skilled manpower is required to carry out complex measurements with specialized high-end tools such as profile projector. To address these challenges, RRCAT has developed cutting-edge, high throughput, high precision, non-contact, machine vision-based inspection and metrology systems. These systems are designed to enhance the accuracy and efficiency of precision metrology for nuclear reactor fuel components and assemblies, leveraging high performance machine vision technology, which is a key to automation of industrial inspection at low cost. These systems have specific advantages of generating high quality data with analytics, report generation and its suitability for integration into existing manufacturing infrastructure for complete plant automation. More than twenty-five indigenously developed machine vision systems for 2D measurements based on shadowgraphy (back illumination), surface quality inspection & optical character recognition (OCR) and 3D measurements using triangulation technique have been deployed, commissioned and operational at various DAE units.

Abstract No: C-58

Atomic Force Microscopy – Imaging and Force Spectroscopy

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Abstract:

Atomic force microscopy (AFM) is a powerful experimental too used to measure the surface topography by imaging and manipulate matter at the nanoscale. It operates by scanning a sharp tip attached to a cantilever over a sample surface. As the tip approaches the surface, intermolecular forces between the tip and the sample cause the cantilever to deflect. This deflection is monitored using a laser beam reflected off the cantilever, allowing for high-resolution topographical maps of the surface.

AFM is versatile, capable of imaging a variety of materials, including metals, organic/inorganic polymers, and biological material, under ambient or controlled environments. It provides not only 3D surface profiles but also information about mechanical properties of the underlying material, such as stiffness and adhesion, by analyzing the intramolecular interactions between the tip and the sample, in dynamic force spectroscopy (DFS) mode.

In our laboratory at TIFR, Mumbai, we use custom-built AFMs to study mechanical unfolding of proteins at the single-molecule level. We also have an AFM equipped with long- range piezo-actuator to image various samples like thin films, DNA and even live zebra fish. My poster will discuss the working-principle of AFM and its different modes, and showcase interesting and exciting results of some of the scientific projects carried out in our laboratory.

Abstract No: C-59

Dynamic Strain-Engineered Plasmonic Nanostructures for Enhanced Electrochemical Oxygen Reduction and High-Performance alkaline membrane H_2 Air Fuel Cells

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Abstract:

The sluggish kinetics of the electrochemical oxygen reduction reaction (ORR) is the limiting cathodic reaction for the low-temperature H_2-Air fuel cell. To avoid the limitations of Pt-based nano-scale materials as ORR catalysts, this work explores the possibility of using a simple plasmonic (Au and Ag) nanosystem for the fuel cell application by exploiting their substantial electrocatalytic activity, stability, and durability towards ORR in an alkaline medium.

We have developed a facile synthetic procedure for the preparation of a porous aggregated network of Au-Ag alloy nanoparticles. When the network structure is formed by controlled aggregation of bimetallic nanoparticles using an appropriate concentration of the aggregating agent (Tsai *et al.*, 2014), the catalytic activity increases as the particles contain high density defect sites, mainly twin boundary. This catalyst shows effective $4e^-$ reduction of O_2, extraordinary methanol tolerance and better durability than Pt/C. In the system-level application, our catalyst shows a peak power density of 98.18 mW cm^{-2} at a current density of 443.7 mA cm^{-2} in a single- cell H_2-air fuel cell which is comparable with a commercial Pt/C catalyst and even shows better performance at higher current density due to which it can serve as a potential cathode catalyst for fuel cell device.

Keywords: Fuel cell; Alloy nanoparticle; Twin boundary; Aggregated network

References:

Tsai, D.H. *et al.* (2014) 'Controlled formation and characterization of dithiothreitol-conjugated gold nanoparticle clusters', *Langmuir*, pp. 3397–3405. Available at: https://doi.org/10.1021/la500044y.

Abstract No: C-60

Quantum enhanced reconfigurable circular polarization receiver using non-linear magneto-electric effect in alkali atomic vapor

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Abstract:

We introduce a novel application of the nonlinear magneto-electric effect (NME) in alkali atomic vapours for medium-frequency (MF) magnetic field sensing. By employing a longitudinal static magnetic field, we demonstrate a projective measurement technique with an exceptional extinction ratio of up to 500:1. This method effectively characterizes the ellipticity of radio-frequency (RF) magnetic field and enables phase- sensitive detection, crucial for medium-frequency communication. Our technique transforms binary phase-shift keyed (BPSK) RF fields into amplitude modulation of optical fields, serving as a versatile receiver for the medium frequency band.

Our experimental setup, utilizing Rb-87 atomic thermal vapor, uses the technique of non-linear wave mixing of one electric field and two magnetic field gives rise to a generation of new optical field of different frequency. The heterodyne detection is used to identify spectral peaks corresponding to different RF magnetic field. The polarization sensitivity of our RF receiver is dynamically adjustable, allowing for the detection of either left or right circular polarization. We demonstrate the high extinction ratio and accurate phase measurement capabilities of our method. This research paves the way for innovative applications in communication and precision metrology for RF magnetic field sensing.

Abstract No: C-61

One-Pot Synthesis of Plasmonic Black Gold Nanoparticles for Efficient Photocatalytic Activity

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Abstract:

"Black gold," is a distinctive plasmonic nanomaterial[1,2]capable of absorbing a broad range of light, from visible to near-infrared wavelengths.[3] It has shown exceptional performance in CO2 reduction, alcohol oxidation, and seawater purification.[4-6] However, its primary limitation lies in its complex multi-step synthesis process, which involves the gradual growth of Au nanoparticles over several days on dendritic fibrous nanosilica (DFNS) support.[3,7-11] Furthermore, the need for solid separation through centrifugation after each cycle is an additional bottleneck.[3]

In this work, we explored a simplified and efficient one-pot synthesis method for producing plasmonic black gold.[12] This approach streamlined the process, reducing the synthesis time from days to hours and eliminating the need for solid separation, thus improving sustainability. Furthermore, DPC-60, synthesized using the one-pot method, demonstrated efficient catalytic performance in CO oxidation under light, achieving 87 % CO conversion at 4.0 W cm^{-2} without external heating. *In situ* DRIFTS studies identified key adsorption sites for CO oxidation, revealing that bridged CO adsorbed on Au^0 sites reacts more quickly than linearly adsorbed CO, with CO on high-coordinated Au^0 sites exhibiting a faster reaction rate than on low- coordinated ones. This one-pot synthesis method accelerates the exploration of black gold's applications across various fields and opens the door to scalable industrial deployment.[12]

Abstract No: C-62

Theoretical Sciences at CEBS

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Abstract:

We discuss research in theoretical physics and mathematics, emphasizing the following areas:

(i) Nuclear Theory: Investigated fluctuations in the ground state masses of nuclei spanning the entire periodic table and established that the fluctuations follow the generalised extreme value distribution. A detailed study of stability of nuclei was carried out using Rene Thom's catastrophe theory and determined existence of third order phase transition in fission processes.

(ii) Mathematical physics: Investigated the entire set of pseudohermitian operators in M_2(C). Established a geometrical classification of these operators in terms of quadrics and also found an alternative proof of the result that a matrix in M_2(C) is PT symmetric if and only if it is pseudohermitian.

(iii) Research work in computational physics is mainly focused on various problems in plasma physics. Nonlinear phenomena in plasma are investigated using indigenously build Particle- In-Cell codes which solve Vlasov-Poisson or Vlasov-Maxwell system of equations. Overview of these activities along with applications in laser-plasma based accelerators and capacitively coupled discharges will be presented.

(iv) In mathematics, the focus is on the topology of homogeneous spaces, including study of maps, and endomorphisms of cohomology, of various homogeneous spaces. We also look at the p-local decompositions of certain quotients of Stiefel manifolds.

Abstract No: C-63

Magnetic domain and spin dynamics for future spintronic applications

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Abstract:

Spintronics is an intriguing subject of research that considers both the charge and spin degrees of freedom of electrons. Our research group at NISER primarily investigates novel materials, physical phenomena, and manipulation techniques to fulfil the demands of present-day technologies and emerging ones. In this context, we concentrate on spin-charge conversion mechanisms, domain and/or skyrmion dynamics of various types of quantum materials. In addition to magnetic domains, skyrmions can provide faster speed, great storage density, and low power consumption in devices. In this regard, we fabricate and study ultrathin films of ferromagnets, synthetic antiferromagnets, and synthetic ferrimagnetic systems. We have expanded our research by considering magnetostriction, a basic material characteristic for flexible spintronics. For spin-to-charge conversion, we are investigating various quantum materials such as transition metal dichalcogenides (TMDs), antiferromagnets, topological insulators, and heavy metals. We also try to tune the magnetic properties via interface engineering in ferromagnetic/organic semiconductors in the context of organic spintronics. Further we are studying magnonic heterostructures, as magnons provide an appealing possibility for effective spin information transmission over long distances. In this poster, we will showcase our activities in the field of nanomagnetism and spintronic which have promising platforms for the emerging field of quantum technology.

Abstract No: C-64

Balloon Facility of Tata Institute of Fundamental Research: pivotal role in advancing scientific research through balloon-borne experiments

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Abstract:

The Balloon Facility of Tata Institute of Fundamental Research (TIFR-BF), an integral part of the Department of Atomic Energy (DAE), plays a pivotal role in balloon- borne scientific research, offering a platform for innovative experiments in atmospheric science, astronomy, quantum communications, and other emerging fields. By leveraging high-altitude balloons, researchers gain unique access to the Earth's stratosphere, allowing them to collect in-situ measurements data in near-space environments that are otherwise inaccessible through conventional means. These experiments contribute to a deeper understanding of atmospheric dynamics, cosmic phenomena, and the development of advanced communication technologies.

In addition to its role in supporting cutting-edge research, the TIFR-BF plays a significant part in educational outreach. It collaborates with academic institutions to offer students hands-on training in space science and technology. These programs not only enhance scientific literacy but also inspire the next generation of engineers and scientists by immersing them in real-world challenges related to space exploration. Students learn to design and develop space instrumentation, gaining valuable practical experience in fields that are pivotal to future space missions.

Through these dual roles—scientific advancement and educational engagement—the TIFR-BF bridges the gap between theoretical science and practical application, fostering innovation while contributing to the development of space technologies. Its work not only strengthens India's capabilities in atmospheric and space sciences but also empowers the country's youth to contribute to the global scientific community.

Abstract No: C-65

Stellar Mass Contributions of Red and Blue Galaxies: Findings from ALFALFA Data

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Abstract:

The various processes and evolutionary phases experienced by galaxies show emissions spanning the entire electromagnetic spectrum. Consequently, a comprehensive understanding of these phenomena requires a multi-wavelength approach.

In this work, I have used the 100% Data catalog of the ALFALFA Survey, a blind HI survey. Durbala et al. has identified counterparts for these HI-selected galaxies in different Galaxy surveys belonging to various observational bands- Sloan Digital Sky Survey (SDSS) and GALEX-UV SDSS WISE Legacy Catalog-2 (GSWLC-2)) and have estimated their Stellar Masses.

The Stellar Mass Estimates of SDSS uses g-i color from optical band (Taylor et al.), and GSWLC-2 mass estimates (Salim et al.) utilize all three bands—optical, UV, and infrared. GSWLC provides more accurate stellar mass estimates because of two additional bands.

We use non-parametric method to constrain the stellar mass function of gas-rich galaxies in the ALFALFA 100% sample for both stellar mass estimates and compare their results.

The data is consistent with the Schechter function with the best-fit parameters M_*, φ_*/1e-3 and α (=10.9,2.9, -1.2). Additionally, we look at the contribution to the total stellar mass function of these galaxies from the red and blue population of galaxies. The red population is well described by following best-fit parameters M_*, φ_*/1e-3 and α (=10.8,2.5, - 0.9), and blue population by M_*, φ_*/1e-3 and α (=10.8,1.0, -1.4). The number density associated with the blue population is 7.69*1e-4, and the number density associated with red ones is 14.56*1e-4. Compared to the overall population, where the red population is 66% of the total stellar mass and rest is contributed by blue population. The gas-rich population of galaxies consists of 15% of the total stellar mass.

Abstract No: C-66

Development and Deployment of Portable D-T Neutron Generator

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Abstract:

A sealed and portable neutron source based on D-T fusion producing monoenergetic

14.1 MeV neutrons has been developed in-house at Bhabha Atomic Research Centre. The neutron generator serves as an import substitute. It consists of cold cathode Penning ion source (PIS), metallic deuterium gas reservoir, beam shaping shroud and tritium target assembly. The PIS generates D+ ions and is powered by a dual mode (pulsed and DC) high voltage power supply. The metallic gas resevoir has deuterium gas adsorbed on its surface and is released by controlled heating of metallic strip to maintain adequate pressure in PIS for plasma formation. A technique for tritium target deposition on titanium film coated copper substrate has also been developed. The D+ ions are accelerated towards target where fusion takes place and neutrons are produced isotropically. The neutron generator has neutron yield of ~ 3 x 10^7 n/s.

The sealed neutron generator has been developed for field applications. This has been used to develop and demonstrate Prompt Fission Neutron (PFN) logger for on- field uranium ore assay in borehole logging. It has also been used for characterization of coal quality and other material characterization applications.

Abstract No: C-67

Development of Advanced Eddy Current Nondestructive Evaluation Techniques for Nuclear Components

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Abstract:

Non-Destructive Evaluation (NDE) plays a crucial role in ensuring the integrity of components and structures in nuclear power plants and hence it has been given paramount importance in the nuclear industry. Advanced eddy current testing (ECT) based NDE techniques have been developed in the authors' laboratory for inspection of several nuclear components at different stages of their life including NDE during fabrication, in-service and post-irradiation examination. This paper highlights key achievements in the development of advanced NDE techniques for applications on components of fast breeder reactors (FBR), FBR fuel cycle and Pressurized Heavy Water Reactors (PHWRs).

ECT has been utilized during the manufacturing stages of nuclear components. Development of saturation ECT along with a novel digital wavelet technique (DWT) based signal denoising methodology have been used to enhance the signal to noise ratio (SNR) for detecting oriented sub-surface flaws and successfully qualifying the nickel tubes used in the fabrication of hydrogen detectors of prototype fast breeder reactor (PFBR). Additionally, advancements in saturation ECT and Sweep Frequency Eddy Current Testing (SFECT), have been instrumental in optimizing the fabrication of metallic fuel pins, ensuring effective sodium bonding and ensuring the structural integrity of clad and fuel slug.

ECT has been extensively used for maintenance and safety checks of components during operation. Remote Field Eddy Current (RFEC) technology has been streamlined to offer in- service inspection solutions for ferromagnetic steam generator tubes of PFBR. Key advancements include in-house development of RFEC probes optimized by finite element modelling, highly sensitive multi-frequency instrumentation for rapid inspection and inspection procedures. This technology has been demonstrated in PFBR steam generator tubes made of modified 9Cr-1Mo steel, with pre-service inspections successfully performed. Additionally, a first-of-its-kind 8-element RFEC array probe has been developed for flaw imaging in SG tubes, along with a sweep frequency RFEC technique for absolute thickness measurement of the tubes. Recently, ECT based inspection of all tubes in two intermediate heat exchanges (IHXs) of PFBR has been successfully conducted to identify vulnerable tubes leading to sodium leakage. Flaws identified by ECT were subsequently confirmed and characterized in detail by stereo videoscopy and ultrasonic internal rotary inspection system. Suitable algorithms and associated software were developed in-house for automatic analysis and imaging of ECT signals obtained in

3600 tubes in each IHX. Furthermore, the development of focused eddy current array probes capable of detecting oriented defects, along with refined scanning methodologies, has enabled successful inspections of calandria tubes during the *en-mass* coolant channel replacement (EMCCR) campaigns for PHWRs, including at KAPS and RAPS.

In Post-Irradiation Examination (PIE) phase, ECT has been successfully used to assess the integrity of the irradiated fuel pins. Development of specialized eddy current probes and inspection methodologies has significantly contributed towards assessing the structural integrity of irradiated carbide and mix-oxide (MOX) fuel pins at different burn-up. The development of encircling EC array probe, along with advanced scanning methodologies, has enabled detailed imaging of carbide fuel pins, allowing for precise localization of indications. Synergistic application of EC technique, Gamma Spectrometry and Neutron radiography revealed fuel clad chemical interaction in 112 GWd/t burnup MOX fuel pins.

Strengths in FEM modelling and simulation have provided valuable insights into complex structural behaviours and electromagnetic field interactions, aiding in both sensor design and inspection processes. The integration of Artificial Intelligence (AI) and Machine Learning (ML) has further advanced defect characterization and analysis, facilitating more accurate and automated interpretation of inspection data. These innovations collectively enhance the capabilities of ECT, driving progress in the inspection and optimization of critical reactor components. This paper summarises the innovation in the field of eddy current NDE.

Keywords: Non-Destructive Evaluation, Electromagnetic Testing, Eddy Current Testing, Eddy Current Array Probes, Remote filed eddy current testing, Sweep frequency eddy current testing, Artificial Intelligence in NDE

Abstract No: C-68

Development of Ceramic and Pyrolytic Graphite Coating for Pyrochemical Reprocessing and Reactors Applications

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Abstract:

Hostile environments envisaged in the pyrochemical reprocessing and Gen-IV reactors, such as high temperature, corrosive molten salts and molten metals and radioactivity, necessitate the introduction of protective coatings offering thermal, chemical and environmental barriers to reactor structural materials thereby improving its performance and durability. The choice of coating materials includes ceramic (oxides, carbides, silicides, borides, etc.), refractory metals (W, Ta, Nb etc.) and pyrolytic carbon/graphite (PyG), which can withstand high thermal loads, temperature, chemically inert or passivating in nature. Towards research and development on ceramic, cermet and alloy coatings, a thermal spray facility consisting of air plasma spray and high-velocity oxy-fuel spray is established. Likewise, for the development of PyG a first-of-its-installed and operational at IGCAR. The key developments for the ceramic and alloys coating behavior of PyG in air, steam; molten salt corrosion behavior under eutectic LiCl-KCl, LiCl-KCl- mould release and anodes for de-oxidation have been successfully demonstrated with 20-25 μm thick PyG coating. The presentation will throw insights into the key results and activities of our recent work carried out in our laboratory on coating development technology for pyrochemical reprocessing and Gen-IV reactors' applications. Keywords: Plasma spray, Ceramic, Pyrolytic graphite, Molten salt, Molten metal, Corrosion

Abstract No: C-69

BARC's High Temperature Reactor Development program with Intermediate (GCR) and High Temperature (HTR) concepts

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Abstract:

BARC’s has been fervently pursuing a High Temperature Reactor (HTR) development program for efficient green hydrogen production. Design and development work has been earlier carried out towards a technology demonstrator concept, CHTR, which was a 100 KWth prismatic block graphite moderated core, and a 20 MWth power floating pebble bed concept, IHTR-20. Both these concepts were designed to be graphite moderated, special TRISO particle fuelled cores, cooled by either molten metal or salt. Also, both the concepts required non-standard special materials to cater the need of very high temperatures.

The Gas cooled reactor is an evolutionary step in the development of high temperature reactors needed for hydrogen production by thermo-chemical processes. The GCRs have an advantage of having single phase coolant allowing higher operating temperatures and higher efficiency needed for hydrogen production. RPDD has been carrying out the physics design of suitable fuel assembly and low power technology demonstrator core for required objectives and to optimize reactor parameters. The demo reactor is a graphite-moderated and CO_2 cooled reactor with an outlet temperature of 650°C. The present paper summarizes these developments.

Abstract No: C-70

Microstructural Characterization of Irradiated FBR Fuels and Structural Materials

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Abstract:

Microstructural characterization using Electron microscopy (EM) plays a vital role in the post irradiation examinations of irradiated fuels and structural materials. The challenges include high levels of radioactivity (□,□,□), limited volumes of homogenous materials and remote specimen preparation, handling etc. The microstructural characterization of irradiated fuels and structural materials of Fast Breeder Test Reactor (FBTR) is being carried out using a customized Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM) in the hot cell facility of Radiometallugy laboratory.

The glove box interfaced SEM fitted with shielded EDS and WDS has been successfully employed for examining various fast reactor fuels such as the PFBR MOX, carbide fuel and the U-Zr metallic fuel, all irradiated in FBTR. The examinations provided information on restructuring behavior of irradiated MOX fuel, fission product and actinide redistribution, as well as porosity distributions in irradiated carbide fuel. The TEM facility consists of fume hood based remote specimen preparation arrangement and examinations in TEM having energy filter.

TEM facility has been extensively used for systematic defect structure analysis of irradiated FBR clad, wrapper (SS 316, alloy D9) and near core structural materials (SS316LN, SS304LN) subjected to various dpa-irradiation temperature combinations. The relevant features of the electron microscopy facility for examining irradiated materials and salient results of the microstructural characterization will be presented.

Abstract No: C-71

Detector Technology for Societal Applications

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Abstract:

The Centre for Medical and Radiation Physics (CMRP) aims to develop detector technologies for societal applications. Currently, the centre is performing R & D on Silicon and gaseous detectors. Primarily these detectors have been used in nuclear and particle physics experiments. However, due to their unique, and excellent particle detection capabilities, they can be adapted for use in societal applications such as radiation dose measurement, proton CT, Positron Emission Tomography (PET) and Muography. In this presentation, I will discuss the current activities and plans for developing such detectors at CMRP, NISER. I will be focusing on the activities related to Silicon Pad Arrays, Silicon Photomultipliers, Resistive Plate Chambers (RPC) and Thick Gaseous Electron Multipliers (THGEM).

Abstract No: C-72

Experience gained during testing, repair and qualification of Intermediate Heat Exchangers during the commissioning phase of PFBR

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Bharatiya Nabhikiya Vidyut Nigam Limited (BHAVINI) Prototype Fast Breeder Reactor (PFBR) Project

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Abstract:

Prototype Fast Breeder Reactor (PFBR) is 500MWe pool type, sodium cooled fast reactor. PFBR has two secondary sodium main circuits and each circuit has two Intermediate Heat Exchangers (IHX). The IHX is a shell and tube type, counter current, sodium to sodium heat exchanger, which transfers the heat from the primary sodium to the secondary sodium in the reactor. The principal material of construction is austenitic stainless-steel grade 316LN. Each IHX has 3600 straight seamless tubes which are expanded and then seal welded to the either ends of top and bottom tube sheets. During the commissioning phase of the reactor, sodium leak was observed in two IHXs located in one of the loops. Both IHXs were removed from the reactor and sodium cleaning was carried out for identification of the leak and root cause analysis. As IHX is a reusable equipment, CO_2+water vapour cleaning process was followed for sodium cleaning. Various inspections and testing were carried out for identification of location of the leak. The equipment was repaired, tested and qualified. In this paper, the experience gained during the sodium cleaning, identification of leak, repair and qualification of IHXs is summarized.

Abstract No: C-73

The Future of India's Nuclear Energy Independence: Large scale thorium utilization via Molten Salt Breeder Reactors (MSBRs)

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Abstract:

More than any other nation, it is India's requirement to have a transition to the large-scale thorium utilization. The Molten Salt Reactors (MSRs) have potential to best utilize thorium as it does not need fuel fabrication and its fuel cycle is highly flexible. MSRs are also good candidates for efficient hydrogen production. In recent years, there is an ardent interest in MSRs by government institutions and private strart-ups alike. The MSR fuel cycle is very adaptable to fissile resources available, it has been demonstrated to work with Th-U and Th- Pu fuels. It can be designed to be a breeder and inherently safe due to liquid fuel mass.

Several countries have initiated comprehensive MSR programs and developing a prototype. DAE is also pursuing an ambitious MSR program with focus on design of an experimental concept core utilizing thorium, integral and irradiation test beds and development of required state-of-the-art MSR technologies. Substantial efforts have been made to design a small, experimental, low power Indian MSR core with molten fuel salt (LiF-BeF2-ThF4-PuF3) flowing in graphite channels. An experimental program has also been initiated to test and address MSR related challenges. The present paper summarizes these developments.

Abstract No: C-74

HPC and AI in IPR

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Abstract:

A large volume of technological research and development done at the IPR is potentially applicable to a wide range of technological needs of the Indian and international research programs. Leveraging AI and high- performance computing (HPC) for larger systems, and more complex physics is being experienced in Institute of Plasma Research (IPR). The convergence of AI and HPC accelerates AI, computer modelling & simulations. IPR has developed AI-driven tools & leveraging high-performance computing (HPC) including for medical diagnostics, security systems like DeepCXR, AIBacilli both tools are optimized to run on CPU/GPU/ARM platforms.

Abstract No: C-75

Constraining long-range interaction using the flavor composition estimates from astrophysical neutrino experiments

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Abstract:

The discovery of new, flavor-dependent neutrino interactions would provide compelling evidence of physics beyond the Standard Model. We focus on interactions generated by the several anomaly-free, gauged, abelian lepton number symmetries that introduce a new matter potential sourced by electrons and neutrons, potentially impacting neutrino flavor oscillations. We estimate constraints on these interactions that can be placed via the flavor composition of the diffuse flux of high-energy astrophysical neutrinos, with TeV-PeV energies. Because we consider mediators of these new interactions to be ultra-light, lighter than 10−10 eV, the interaction range is ultra-long, from km to Gpc, allowing vast numbers of matter particles inside the celestial bodies to contribute to this new potential. We leverage the present-day and future sensitivity of high-energy neutrino telescopes and of oscillation experiments to estimate the constraints that could be placed on the coupling strength of these interactions. We predict that the present flavor composition estimates from IceCube would be unable to put constraints on certain symmetries. Meanwhile, for the other symmetries, the IceCube neutrino telescope demonstrates the potential to constrain flavor-dependent long-range interactions. We also estimate improvement in the sensitivity due to the next-generation neutrino telescopes.

Abstract No: C-76

Order of Strain for Continuous Gravitational Wave from Galactic Neutron Star Population

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Abstract:

In this work, we have performed an initial estimate of the Continuous Gravitational Wave (CW) strain across the entire frequency spectrum obtainable from spinning neutron stars in our galaxy. For this purpose, we use observed neutron stars' spin frequencies and spin-down rates, observed with radio telescopes as provided in the Australia Telescope National Facility (ATNF) pulsar catalog. The sampled population in the frequency and spin-down parameter space is obtained by applying the Kernel Density Estimation (KDE) fit of all the pulsars in the ATNF catalog. We discuss the CW strain as a function of source properties including spin frequency, spin-down, moment of inertia, ellipticity, and source-distance. Along with considering a fiducial value of the moment of inertia of the neutron stars, we have estimated the Newtonian and post-Newtonian (empirical approximation) values by computing it from the Nuclear Equation of State with the observed mass distribution of the neutron star population. We then apply observational constraints from NICER, XMM-Newton, and LIGO-Virgo Collaboration on the neutron star equation of State and select the valid ones. The estimations for all these source properties are combined together to predict different observational scenarios for well-known search methods, fully coherent and semi-coherent, to detect CW signals with present and future-generation GW detectors.

Abstract No: C-77

The large-scale regular magnetic field of the Andromeda galaxy M31

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Abstract:

We use Fourier analysis to model the large-scale mean (regular) galactic magnetic field (GMF) of the galaxy M31. Earlier analysis using multi-wavelength data (6, 11, and 20 cm) from the Effelsberg 100 m and Very Large Array (VLA) telescopes indicated that the axisymmetric large-scale GMF component (mode 0) is sufficient for modelling the outer radii ~ 8-14 kpc) while a weak quadri-symmetric term (mode 2) is present along with the dominant axisymmetric term at smaller radius (6-8 kpc). We use the recently obtained radio continuum Effelsberg data at 3.56, 6.18, and 11.33 cm wavelengths plus the previous VLA data at 20.46 cm and find sub-dominant contributions from modes 1, 2, and 3 along with a dominant axisymmetric term (mode 0), consistently throughout the galaxy. The foreground rotation measure due to the Milky Way (RM_{fg}) is found to be -105 ± 2 rad.m^{-2} for the outer three rings (8-14 kpc) and -132 ± 3 rad.m^{-2} for the ring 6-8 kpc. The pitch angle of the m = 0 mode (p_0) is found to be similar (15° to -21°) over the radial range studied. The maximum strength of the mean magnetic field coincides with the intensity peak of the bright radio ring at ~ 11 kpc.

Abstract No: C-78

Exploring the origin of exchange bias and spin glass behaviour in 6H Hexagonal perovskite structure

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Abstract:

Recent research has highlighted the prominence of double perovskites for their diverse properties by incorporating elements across the periodic table. Among them, the hexagonal double perovskite is a subject of growing interest for its potential quantum properties. Our study focuses on the 6H hexagonal double perovskite $Ba_3Co[Co_{0.25}Ru_{0.75}]_2O_9$, revealing mixed valence states of Co and Ru ions and notable charge transfer phenomena. By analyzing metal ion Wyckoff positions and considering structural and magnetic properties, we uncover insights into exchange bias mechanisms. Our study underscores the significance of hexagonal perovskite structures in yielding giant exchange bias with appropriate ionic compositions, highlighting the role of rational material design.

Abstract No: C-79

Supersymmetric Black Hole Hair and AdS_3 x S^3

Subhodip Bandyopadhyay*, Yogesh K. Srivastava, Amitabh Virmani

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Abstract:

The 4D-5D connection allows us to view the same near horizon geometry as part of a 4D black hole or a 5D black hole. A much-studied example of this phenomenon is the BMPV black hole uplifted to 6D with flat base space versus Taub-NUT base space. These black holes have identical near horizon AdS_3 x S^3 geometry. In this paper, we study modes in AdS_3 x S^3 and identify those that correspond to supersymmetric hair modes in the full black hole spacetimes. We show that these modes satisfy non-normalisable boundary conditions in AdS_3. The non-normalisable boundary conditions are different for different hair modes. We also discuss how the supersymmetric hair modes on BMPV black holes fit into the classification of supersymmetric solutions of 6D supergravity.

Abstract No: C-80

Overview of the Dark Matter and CEνNS Search at NISER

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Abstract:

Rare event search experiments, like detecting dark matter and Coherent Elastic Neutrino Nucleus Scattering (CEνNS) - explore new physics within and beyond the Standard Model. Astronomical observations strongly suggest the existence of dark matter, but no direct experimental evidence has yet been found. The SuperCDMS (Super Cryogenic Dark Matter Search) experiment is a second-generation direct dark matter search experiment currently under construction approximately 2 km underground at SNOLAB, Canada. The experiment is expected to achieve world-leading sensitivity for low-mass dark matter candidates (< 10 GeV/c^2). CEνNS creates the ultimate background for direct dark matter search. Detection of CEνNS enables us to understand the nature of neutrinos, such as their magnetic moment, millicharge, and new mediators of interactions. Modern dark matter detectors are sensitive to measure the small but detectable recoils produced by the CEνNS process. Reactor facilities provide an ideal environment for studying CEνNS due to their abundant neutrino flux in the MeV energy range. NISER, in collaboration with Texas A&M University, USA, has developed detectors that can be used for rare event searches. We will present an overview of NISER activities as part of the SuperCDMS experiment and the possibility of CEνNS study using the APSARA-U reactor facility at BARC.

Abstract No: C-81

Evolution of Galactic Magnetic Fields & Scaling Relations in Radio Continuum

Sukanta Ghosh[1♠], Luke Chamandy[1], Charles Jose[2], Luiz Felipe S. Rodrigues[3]

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Abstract:

Magnetic fields are ubiquitous throughout the universe. Observations suggest that galaxies possess large-scale, ordered magnetic fields with several micro-Gauss (μG) strengths, spanning kiloparsec (kpc) scales. The dynamo theory, which explains the amplification of these magnetic fields, provides a theoretical framework to describe their evolution. Since dynamo equations are highly parameterized and galaxy properties evolve over time, understanding the relationship between magnetic fields and galaxy evolution is crucial.

In this work, we aim to establish statistical scaling relations between magnetic field observables and key galaxy properties. To achieve this, we utilize GALFORM, a semi-analytic galaxy formation model, in combination with MAGNETIZER, a dynamo model that tracks the evolution of magnetic fields within galaxies. Specifically, we investigate the synchrotron flux density (S_I) emitted by cosmic rays accelerated by galactic magnetic fields. Our analysis reveals strong correlations between S_I, the star formation rate (SFR), and the rotational speed (V_{rot}) of galaxies. We find that S_I scales as a power law with both parameters: $S_I \propto SFR^{0.8}$ and $S_I \propto V_{rot}^{2.34}$, consistent with observational data. These findings indicate a strong connection between galactic magnetic fields, star formation, and rotational dynamics, offering new insights into their co-evolution with galaxies.

Abstract No: C-82

Threeloop QCD-EW Correction to the Drell-Yan Process

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Abstract:

To test validity of the Standard Model and find the unambiguous signature of beyond the Standard Model phenomena, sufficiently accurate precision calculation is indispensable, along with precise, equally experimental determination. Drell-Yan process is a standard candle for the precision studies. With impressive luminosity, the current Run 3 of the LHC, and upcoming HL-LHC (Run4-6) will potentially open a new window of precision measurement of the SM parameters. Hence, we aim to calculate the three-loop QCD$\otimes$EW corrections ($\alpha_s^2\alpha$) to the neutral current Drell-Yan process. Among the several steps of the calculation, we have made significant progress in calculating the Virtual three-loop form factor. We have found 388 diagrams contributing to the pure virtual process. We calculate the analytical expression of the projected amplitude for each of the diagrams in terms of the kinematic variables and scalar Feynman integrals. After the IBP reduction, we found over 300 master integrals, and the primary focus is on calculating the master integrals in terms of multiple polylogarithms. In this session, we aim to present techniques to calculate the Form factors and eventually measurable observables and our progress in calculating the three-loop correction to the Drell-Yan cross-section.

Abstract No: C-83

Modulating Electronic Structure of Metal Nanostructures through Strain Engineering to Enhance Electrocatalytic Properties

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Abstract:

Direct alcohol fuel cells (DAFCs) rely on alcohol oxidation reactions (AORs) to generate electricity. These reactions require catalysts with an optimized electronic structure and a high surface-to-volume ratio to accelerate the sluggish AORs. We have synthesized Pd-based core-shell structures with thin shells and nanowire networks that offer a very high surface-to-volume ratio, leading to an increased number of catalytically active sites on the surface. To further enhance the intrinsic activity of the nanostructures, we employed a strain-engineering strategy, which shifts the d-band center, thereby tuning the adsorption ability of the catalysts and optimizing catalytic activity. In the core-shell nanostructures, a Pd shell is epitaxially grown on Au@Ag core–shell nanorods, introducing tensile strain in the Pd shell. For Pd-based nanowire networks, heteroatoms are introduced into the Pd lattice to induce strain. These core-shell nanostructures and nanowire networks exhibit approximately 23- and 13-times higher activity towards AOR, respectively, compared to commercial Pd/C catalysts.

Abstract No: C-84

Relativistic (Spin) Hydrodynamics and Transport Phenomena in Heavy Ion Collision.

Soham Banerjee♠, Sourav Dey, Samapan Bhadury, Wojciech Florkowski, Radoslaw Ryblewski, Hiranmaya Mishra, *Amaresh Jaiswal.

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Abstract:

We investigate the spin polarization of Λ hyperons in non-central heavy ion collisions observed during Au-Au collisions at 200 GeV. Our approach combines a relativistic kinetic theory framework, which includes spin degrees of freedom and accounts for dissipative corrections, with hydrodynamical modelling to study the longitudinal spin polarization. Additionally, we use the Kurganov-Tadmor (KT) method to solve the hydrodynamics evolution of the quark-gluon plasma (QGP), helping us explore spin polarization phenomena further. Our research also examines the transport properties of these systems from both macroscopic and microscopic perspectives. We use Non-equilibrium Quantum Field Theory (QFT) methods, including Kubo techniques and entropy current analysis, to understand transport coefficients in relativistic (spin) hydrodynamics. These coefficients are evaluated at both weak and strong coupling limits, showing how they align with kinetic theory results and non-perturbative physics. Our work aims to connect theoretical predictions with experimental observations in (spin) hydrodynamics and heavy-ion collisions.

Abstract No: C-85

Shear and Bulk viscosity for the pure glue theory using an effective matrix model

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Abstract:

At nonzero temperature, the deconfining phase transition can be analyzed using an effective matrix model to characterize the change in holonomy. The model includes gluons and two-dimensional ghost fields in the adjoint representation. This ghost field is responsible for decrease in the pressure as $T \rightarrow T_d$, with T_d, the transition operator for deconfinement. Using the solution of this matrix model for a large number of colors, the parameters of the ghost fields are adjusted so that the expectation value of the Polyakov loop is close to the values from the lattice. The shear (η), and bulk viscosities (ζ) are computed in weak coupling but in non-zero holonomy. (η/s) decreases as we approach T_d, it is still well above the conformal bound. In contrast, (ζ/s) is largest at T_d, comparable to (η/s), then falls off rapidly with increasing temperature and is negligible by 2 T_d.

Abstract No: C-86

Fluid acceleration hinders caustics for finitely dense particles

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Abstract:

Caustics in fluid flow are singular features in particle number density. Their occurrence has numerous consequences. Through stability analysis and direct numerical simulations, we show that fluid acceleration and relative density significantly alter the formation of caustics and the regions they occupy in background turbulence.

Abstract No: C-87

Next Generation Soft Semiconductor: Challenges and Opportunities

Brijesh K Patel [1 ♠], Amogh K Ravi [1], Shubham Gupta [1], Sagar Singh [1], Sudip De [1], Shreya Pandit [1], Chandan Gupta [1], Sujit Kumar [1], Vaishali Arunachalam [1], Pabitra K Nayak [1 *]

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Abstract:

Organic semiconductors hold significant potential as the cornerstone of next-generation optoelectronic devices, offering a versatile platform for applications such as solar cells, light-emitting diodes (LEDs), and transistors. Our research focuses on the enhancement of both optical and electronic properties of these devices, aiming to optimize their performance and efficiency. By systematically tuning material characteristics and device architectures, we seek to push the boundaries of their functional capabilities. In parallel, we are conducting a detailed investigation into the fundamental mechanisms governing charge transport and charge carrier dynamics in both organic semiconductors and perovskite solar cells, which are critical for efficient energy conversion and device performance. A central aspect of this work involves probing the stability of these devices under operational conditions, a key challenge that affects their long-term viability in real-world applications. Through this dual approach of material improvement and mechanistic understanding, we aim to contribute to the advancement of optoelectronic technologies, making them more competitive for large-scale deployment in energy and communication systems.

Abstract No: C-88

14 MeV Neutron Generators: Bridging the Gap between Research and Application

Sudhirsinh Vala, Mitul Abhangi, Ratnesh Kumar, Himanshu Sharma, Mahendra Kumar Panda, H L Swami, Swapnil Choudekar, Rajesh Kumar

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Abstract:

The Institute for Plasma Research (IPR), India, has recently launched an advanced 14 MeV neutron generator based on Electron Cyclotron Resonance Ion Source (ECRIS) technology. This generator can produce 10 12 neutrons per second, in both continuous and pulse modes. Deuterons from the ECRIS are aimed at a titanium tritide (TiT) target, creating fast neutrons. These neutrons are essential for fusion experiments, electronics testing, and neutron radiography. Neutron emission from the generator varies over time due to changes in beam current and the wear of the tritium target. Continuous monitoring of neutron emission is critical for accurate results. Various independent techniques are used for this, including diamond-based detectors, proportional counters, and foil activation. These methods ensure the neutron flux is accurately measured. To guarantee precise neutron yield measurements, these tools are cross-checked with the associated alpha diagnostic technique. Our research paper details these measurement techniques, highlighting their importance in linking research to practical applications.

MATHEMATICS

Abstract No: D-1

Pointwise Lipschitz functions

Arindam Mandal♠, Anil Karn

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Abstract:

The presentation will begin by defining "Pointwise Lipschitz functions" and exploring their connection to Lipschitz functions. We will then use Stone-Čech compactification to relate these concepts to the space of bounded continuous maps.

Abstract No: D-2

Continuous Galerkin Spectral Element Method (CGSEM) for compressible fluid flow

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Abstract:

Continuous Galerkin (CG) Methods are usually not a good choice for convection dominated problems and one usually needs to use some stabilization techniques like Streamline upwind Petrov–Galerkin (SUPG) or Discrete Galerkin (DG) methods. Some recent developments make it interesting to again explore CG methods, including split forms that enforce additional consistency like that of kinetic energy, internal energy and entropy, and gradient penalty which helps to reduce dispersion errors. In this work, we are developing and studying CG methods for compressible flows by performing tests on the utility of these novel techniques for Large Eddy Simulations (LES) and Direct Numerical Simulations (DNS). A parallel code based on continuous Galerkin spectral element method (CGSEM) for Cartesian grids has been developed and is being validated on benchmark problems. We report our initial results on 1/2/3-D test problems and highlight the benefits of some of these techniques.

Abstract No: D-3

AI as Tool for Creating Digital Teaching Aids

Dr. Asheesh Mishra

Principal- Aecs-3, Tarapur

Abstract:

Artificial intelligence (AI) is revolutionizing the way educators create and deliver digital teaching aids, offering new possibilities for interactive and personalized learning experiences. This poster presentation focuses on the application of AI tools in the development of digital content, including automated lesson planning, intelligent content creation, and adaptive multimedia aids. AI- powered platforms enable teachers to generate high-quality educational resources such as videos, interactive simulations, and quizzes tailored to individual learning needs. The presentation will explore how these tools streamline the content creation process, reduce workload, and enhance student engagement. By examining case studies and practical examples, this work demonstrates how AI can be harnessed to create dynamic, accessible, and flexible teaching aids that elevate both teaching efficiency and learning outcomes.

Abstract No: D-4

Wave-vortex interactions in the ocean

Rajendra S. Rajpoot♠, 1 and Jim Thomas*, 1, 2

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Abstract:

In oceanic fluid flow, waves and slowly evolving coherent eddies are common. These coherent eddies contain significant kinetic energy, and while many studies suggest mechanisms for its dissipation, the exact pathways remain unclear. One possible mechanism of dissipation of kinetic energy is through interactions with near-inertial waves (NIWs), which have frequencies close to the local Coriolis frequency. To investigate NIWs-coherent eddies interactions, we conducted numerical experiments analysing turbulent exchanges between NIWs and barotropic vortices of both cyclonic and anticyclonic types. In these experiments, the Rossby number (*Ro*) was varied by adjusting the ratio of inertial to Coriolis forces. Additionally, three types of flow decompositions were applied: barotropic-baroclinic, balance-wave, and slow-fast.

Our findings reveal notable differences in vortex breakdown between cyclonic and anticyclonic cases. Anticyclonic cores break down first and dissipate, while cyclones primarily break at the periphery with less dissipation. In the low *Ro* regime, all three decompositions lead to similar dynamics, in contrast to the high *Ro* regime. Moreover, the fast component of the decomposed flow field exhibits significantly greater energy dissipation than the slow component. We found the balance-wave decomposition unsuitable for high *Ro* flows, while the slow-fast decomposition is more effective. These insights enhance our understanding of turbulent energy exchanges in wave-vortex interactions in the ocean.

Abstract No: D-5

Application of DFT in combinatorics

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Abstract:

In this talk, we will present two applications of discrete Fourier transform in additive combinatorics. One of them is Roth's theorem which states that a subset $A \subset N$ with positive upper density contains an AP of length 3. Another is Furstenberg-Sarkozy theorem which talks about the square difference sets. We will present the idea of the proof of these two results, which includes some convolution identities and density increment argument.

Abstract No: D-6

Integrating ICT Tools in Education for AEES Schools: A Vision for the Future

Mrs. Sona O K

Post Graduate Teacher (SS) National ICT Awardee

Abstract:

Advancements in Information and Communication Technology (ICT) have revolutionized various aspects of our lives, and education is no exception. Integrating ICT tools into the classroom has the potential to enhance learning experiences, improve student engagement, and prepare students for the digital age.

Proposed ICT Tools and Their Applications

- **Bleder:** A versatile tool used to create stunning 3D graphics, animations, and interactive content
- **ClassDojo:** A Classroom management tool for tracking behavior, communication, and student progress.
- **Animaker:** Animation creation tool for storytelling, presentations, and educational content.
- **Biteable:** Animated video creation platform for creating engaging videos for lessons, projects, and
- **Krita**A free and open-source digital painting and animation software
- **LiveWorksheets:** Interactive worksheets that allow students to practice skills and receive immediate feedback.
- **GoFormative:** Formative assessment tool for creating quizzes, assignments, and surveys.
- **Quizzalize:** Gamified quiz platform for interactive learning and assessment.

By strategically integrating ICT tools into the educational landscape of AEES schools, we can create a more engaging, effective, and future-ready learning environment. These tools have the potential to empower students, enhance teaching practices, and prepare students for the challenges and opportunities of the digital age.

Abstract No: D-7

Weighted Bilinear Multiplier Theorems in Dunkl Setting via Singular Integrals

Suman Mukherjee ♠*, Sanjay Parui

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Abstract:

The Dunkl operators, introduced by Charles F. Dunkl, can be considered as generalizations of the ordinary directional derivative operators. Through the well- established connection between the Fourier transform and the partial derivative operator, Dunkl operators introduce a new operator that generalizes the classical Fourier transform, called the Dunkl transform. This signifies the commencement of the analytical aspect of Dunkl theory, a thorough initiative to generalize the results of classical Fourier analysis and the theory of special functions to this setup related with root systems and reflection groups. The goal of this work is to present weighted inequalities for bilinear multiplier operators for the Dunkl transform, with multiple Muckenhoupt weights, using the theory of multilinear Calderón-Zygmund type operators in the Dunkl setup. This is based on a joint work with Sanjay Parui.

Abstract No: D-8

Orbital Free Density Functional Theory and Exploring Prospects of Non-Local Kernel

Abhishek Bhattacharjee ♠ *, Dr. Subrata Jana, Dr. Prasanjit Samal

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Abstract:

In the light of recent progress of Orbital-Free Density Functional Theory (OFDFT) based on approximation of non-local (NL) Kinetic Energy Density Functionals (KEDFs), one can foresee the prospects that lies ahead in terms of computational efficiency and dealing with large scale systems. It is important to mention that, accuracy of OFDFT depends on the approximations made for KEDFs. Till now, the most accurate KEDFs are based on NL kernels constructed from the linear response theory of homogeneous electron gas (HEG). In this talk, we explore beyond the HEG by employing a more general kernel based on the jellium-with-gap model (JGM). We propose a new NL-KEDF that incorporates several new features, such as (i) having the correct low momentum(q) limit of the response function for metals and semiconductors without any modelling term, (ii) the underlying kernel is density-independent, and most importantly, (iii) parameter-free. The accuracy and efficiency of the proposed JGM NL-KEDF have been demonstrated for several semiconductors and metals. The encouraging results indicate the utility and predictive power of the JGM kernel for NL KEDF developments. This approach is also physically appealing and practically useful as we have presented a general formalism to incorporate the gap kernel in all existing Lindhard-based functionals.

Abstract No: D-9

High-frequency stability estimates for some inverse boundary value problems

Ajith Kumar T♠, Anupam Pal Choudhury*

National Institute of Science Education and Research, Bhubaneswar

Abstract:

We will discuss our recent results on the high frequency stability estimates for the linearized inverse boundary value problems for the Schrodinger equation and biharmonic operator with constant attenuation in some bounded domains.

EARTH SCIENCE

Abstract No: E-1

Forest Transition and its Hydro-Climatic Impacts in the Indian Himalayas: Inferences from Field Observations and Model Simulations

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Abstract:

Climate warming, large-scale plantations, and changing fire regimes are reshaping the Indian Himalayas, with moist, broadleaved oak forests replaced by dry, fire-prone Chir pine. This transformation raises concerns over the loss of vital ecosystem services like soil moisture retention, streamflow, and biodiversity, which are essential for local communities. Field stations were established in Chir pine and mixed-oak forests in Uttarakhand, India, to assess the hydro-climatic impacts starting in April 2022. We combined field observations, including Bowen ratio (BR) surface fluxes, meteorology, streamflow, soil moisture, and transpiration, with high-resolution modeling. BR sensors at 30 m and 18 m heights in Chir pine and mixed-oak forests showed that sensible heat flux exceeded latent heat fluxes for both forests during the dry season (May–June 2024). However, the latent heat flux for Chir pine (~200 W/m²) was slightly higher than mixed-oak (~150 W/m²). During the monsoon, latent and sensible heat fluxes balanced, yet evapotranspiration remained higher in Chir pine (~300 W/m²) than in mixed oak (~200 W/m²). This is supported by sap-flux and soil moisture data. These observations are integrated into a regional hydro-climatic model, providing insights into the ecological consequences of forest cover changes in the Himalayas.

Abstract No: E-2

Photometric Analysis of Dwarf Planet Ceres Using Disk-Resolved Observations from NASA Dawn VIR data

♠ Sourav Mahato1, * Guneshwar Thangjam1

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Abstract:

The reflectance measured by spacecraft from planetary bodies varies in amplitude based on the positions of both the spacecraft and the Sun relative to the body. Additionally, it is influenced by the macroscopic roughness of the planet and the scattering behavior of the regolith at a microscopic level. To compare images from the same or different instruments or planets, it is essential to normalize the measured reflectance to a standard viewing geometry. This normalization is achieved through photometric modeling, which also provides a quantitative understanding of the physical surface properties of the planetary body.

We present a detailed analysis of the spectrophotometric properties of the dwarf planet Ceres, utilizing disk-resolved observations in the visual-to-infrared (VIS-IR) spectral range. The data, acquired by the VIR imaging spectrometer onboard NASA's Dawn mission, spans a phase angle range of 0° to 133°. Photometric corrections were performed using Hapke's model [1] to standardize observation geometry, allowing the creation of albedo maps of Ceres' surface.

Our analysis incorporates data from five mission phases: Ceres Approach (CSA), Rotational Characterization 3 (RC3), Ceres Transfer to Survey (CTS), Ceres Survey (CSS), and Extended Mission Phase (XMO4). To enhance the accuracy of phase curve modeling, we introduced a per-phase angle filtering process to exclude outliers. The low phase angle coverage provided by XMO4 data enabled modeling of shadow-hiding opposition effect (SHOE) parameters within Hapke's framework, while asymmetry factors were derived using the two-term Henyey-Greenstein (2HG) phase function [2]. Phase curves were fitted across the 0.465–4.05 micrometer range [3] in a two-step process, determining a wavelength- independent roughness parameter before fitting wavelength-dependent parameters [4]. Current efforts focus on validating the estimated parameters, with findings demonstrating good agreement with existing literature.

References:
[1] B. Hapke, (2012), Cambridge University Press. [2] J.-Y. Li et al., (2019), Icarus, 322, 144-167. [3] M. Ciarniello et al., (2017), A&A, 598, xx [4] H. Sato et al., (2014), Journal of Geophysical Research: Planets, 119, 8, 1775-1805

Abstract No: E-3

The Palghar intraplate earthquake swarm – a tale of coupled fault systems, aseismic slip and deep-crustal fluids(?)

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Abstract:

The Palghar earthquake swarm in Maharashtra, within India's stable continental interior, began in November 2018 and continued until late 2023, generating over 10,000 earthquakes ranging from M4.4 to 0.5. The underlying causes of this intense seismic activity are not fully understood. We combined geodetic and seismological data to investigate the swarm's origin and evolution. We derived 1D velocity models and relocated seismicity with horizontal uncertainties within a few tens of meters and depth uncertainties of a few hundred meters using cross-correlation of differential travel times. Relocated seismicity shows two parallel, curved, sub-vertical faults with earthquakes starting at 4 km depth near the western fault and spreading to the eastern fault. InSAR observations reveal that the ground deformation is mainly due to dominant normal slip on these faults. The largest earthquakes (M 4.4 to 3.0) show normal focal mechanisms, with 50% having stress drops below 1 MPa. We find that the catalog-derived seismic moment is consistently about an order of magnitude smaller than the geodetically inferred moment. The swarm's association with aseismic slip, diffusive seismic migration, and low-stress drops suggests it occurred in a fluid-enriched environment, raising questions about the role of fluids in seismic swarms within the Indian plate interior.

Abstract No: E-4

Probing Indian Precambrian terranes for their crustal evolution and potential to host Li and REE

Tiyasha Basu1,2♠, Tapabrato Sarkar3, and Priyadarshi Chowdhury1,2*

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Abstract:

Rare Metals (RMs; e.g., Li, Ti, Nb, Ta, Th, and U) and Rare Earth Elements (REEs) are essential for diverse industries such as nuclear energy, defence, IT, and the transition to clean energy in India. But their low natural abundance and the rarity of economically viable deposits pose significant supply risks.

Co-genetic granite-pegmatite systems are promising sources for economically viable RM-REEs. They represent high fractionated igneous melts with potential enrichment of RM-REEs – up to ~500 times above typical crustal levels (Koopmans et al., 2023, Geology). However, the formation processes and diagnostic features that can aid in the discovery of new deposits remain poorly understood (e.g., Singh et al., 2018, J. Geol. Soc. India).

India's vast granite exposures, especially in Archean-Proterozoic crustal terranes offer an opportunity to study the evolution of igneous melts into RM-REE-rich deposits. Our research focuses on granites and associated pegmatites from the Bastar and Singhbhum cratons to address: (1) the formation of highly evolved melts enriched in RM-REEs, (2) identifiable features (e.g., field associations, mineral assemblages) that can aid in locating new granite-pegmatite systems with high RM-REE contents, and (3) the occurrence of RM-REEs within mineral structures to optimize their extraction.

Abstract No: E-5

Cosmochemistry: Understanding Formation and Evolution of the Solar System

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Abstract:

Cosmochemistry if the study of extraterrestrial materials (EMs) to understand the early solar system processes in the solar protoplanetary disc, the evolution of different bodies in the solar system and linking them to the origin of the Earth and terrestrial planets, Earth's atmosphere, and life in general. It is a highly interdisciplinary science and involves the use of state-of-the art analytical instruments. EMs primarily consists of meteorites that are derived from asteroids, Moon and Mars, fossil meteorites, micrometeorites, interplanetary dust particles (IDPs) and samples returned by robotic and manned space missions. We will present our work on study of: (a) rare groups of meteorites called carbonaceous chondrites to understand the thermal evolution of their parent asteroids and cause of isotopic fractionation in the early solar system; (b) surface processes active on the Moon, Mercury and asteroids and their implications for the change in surface composition with time; (c) link between past flux of EMs to Earth and large scale climate change events and dynamics in the asteroid belt; (d) asteroid impact related shock and phase transformation of silicate minerals; (e) presolar and refractory grains to infer stellar nucleosynthesis and causes of isotopic heterogeneity in the solar protoplanetary disc.

Abstract No: E-6

Exoplanet Origins, Atmospheres and Interiors: The New Frontier

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Abstract:

One of the most exciting developments in astronomy and astrophysics, particularly in planetary astrophysics, is the discovery of planets around stars other than our own Sun, known as 'exoplanets.' These discoveries have revealed an astonishing diversity in the physical characteristics of exoplanets, including their masses, temperatures, radii, orbital properties, and host stars. The exoplanets known today range from super Jupiters to Earth-sized rocky planets, spanning a wide range of temperatures, with several located in the habitable zones of their host stars.

In this poster, we will discuss how these planets form, why they differ significantly from those in our solar system, and the ingredients available to build them. Additionally, we'll delve into the methods used by our 'Exoplanets and Planetary Formation' research group at SEPS, NISER, to study the atmospheres and interiors of these exoplanets. Our research combines ground and space-based observations with atmosphere-interior coupled models to characterize these planets. Finally, we will outline the near future of this emerging frontier, considering the significant advances expected from space-based facilities such as JWST, PLATO, the Roman Space Telescope, and ARIEL, as well as large ground-based facilities like the ELT. We will also discuss NASA's proposed flagship, large infrared/optical/ultraviolet space telescope for 2040 — the Habitable Worlds Observatory (HWO) — and ESA's mid-infrared space interferometer concept, LIFE.

Abstract No: E-7

Exoplanets and the Search for Habitable Worlds

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Abstract:

For centuries, humans have wondered about the existence of planets around stars, other than our own Sun. However, for the first time in human history we have the capability not just to find, but also to characterize these far away worlds, termed as "Exoplanets". In this poster we will show the astonishing variety of exoplanets that have been discovered and techniques used to find them. We will discuss how we study exoplanet atmospheres, using observations from various telescopes and planetary atmosphere models. We will present SANSAR (Suite of Adaptable plaNetary atmoSphere model And Retrieval) a flexible planetary atmosphere model framework developed at NISER for modelling and interpreting the observations of wide range of planetary atmospheres including exoplanets, planets in our solar system as well as the earth. We will show our most recent discoveries using SANSAR and ATMO when applied to observations from Hubble and James Webb Space Telescope (JWST), including detection of CO2 for the first time in an exoplanet atmosphere. Finally, we will discuss where we are heading in our quest to demystify these far away worlds and in our search for habitable planets in our galaxy.

COMPUTER SCIENCE

Abstract No: F-1

Machine Learning and Robotics at NISER.

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Abstract:

The School of Computer Sciences at the National Institute of Science Education and Research (NISER), Bhubaneswar is engaged in cutting-edge research in Machine Learning, Robotics, and other areas within Computer Science. In this poster presentation, the authors, who are actively involved in these research fields, showcase their work. The research encompasses the application of machine learning to computer graphics, graphs, and large language models using state space models, as well as efficient pruning techniques for neural networks to enable them to run on low-energy systems without compromising accuracy. Novel techniques employed in this research include, but are not limited to, using classical orthogonal systems, quaternions, synthetic minority oversampling techniques, and selective scan of structured state space sequence modeling. In robotics, the school is developing novel autonomous driving systems and collecting high-quality data for use in these systems; and concurrently, collaborating with the National Health Mission, Odisha, to develop systems for certifying healthcare facility quality across the state of Odisha.

Abstract No: F-2

Tractability of Packing Vertex-Disjoint A-Paths under Length Constraints

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Abstract:

The (A, ℓ)-Path Packing problem (ALPP) involves determining if a graph contains k vertex-disjoint paths of exact length ℓ that connect distinct vertices in a subset A. While the problem is known to be fixed-parameter tractable (FPT) when parameterized by k + ℓ, it remains Para-NP-hard when parameterized by either k or ℓ alone. Previous research showed ALPP is W [1]-hard when parameterized by the pathwidth+|A|.

This paper extends those findings, demonstrating that ALPP is unlikely to be FPT even when considering the larger parameter |A| + distance to path (dtp), using a randomized reduction technique inspired by the isolation lemma. This result suggests that no FPT algorithms exist for ALPP when parameterized by structural parameters like feedback vertex set (FVS) + |A| or distance to disjoint union of paths (dlf) + |A|. However, ALPP is FPT when parameterized by vertex cover (vc) or cluster vertex deletion (CVD) combined with |A| or |ℓ|. These findings indicate the complexity of ALPP in relation to different graph parameters, offering insights for future research on path-packing problems.

MEDICAL AND RADIOLOGICAL PHYSICS

Abstract No: G-1

Medical Physics for Cancer Care and Treatment

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Abstract:

The Centre for Medical and Radiation Physics (CMRP) is running a Master's program in Medical and Radiological Physics. After the completion of 2 years of teaching and one year of mandatory internship, the students can work as Medical Physicists at various Radiation Oncology centres. These students are trained in the practical aspects of treatment planning, radiation dosimetry, quality assurance, and radiation protection for radiation therapy treatment machines. Besides this, there are other upcoming facilities at CMRP. The NABL-accredited calibration laboratory aims to provide calibration services for the therapy level dosimeters in India's eastern and north-eastern regions. The Gamma Irradiation Chamber facility will help perform the student's experiments and some radiobiological studies that may be used for better cancer care. The medical cyclotron facility will produce radioisotopes for medical diagnosis and therapy. Besides this, CMRP has organised various outreach programmes for students of NISER as well as outside NISER. This presentation will discuss the current activities, status, and plans for the upcoming facilities.

Abstract No: G-2

Detector Technology for Societal Applications

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Abstract:

The Centre for Medical and Radiation Physics (CMRP) aims to develop detector technologies for societal applications. Currently, the centre is performing R & D on Silicon and gaseous detectors. Primarily these detectors have been used in nuclear and particle physics experiments. However, due to their unique, and excellent particle detection capabilities, they can be adapted for use in societal applications such as radiation dose measurement, proton CT, Positron Emission Tomography (PET) and Muography. In this presentation, I will discuss the current activities and plans for developing such detectors at CMRP, NISER. I will be focussing on the activities related to Silicon Pad Arrays, Silicon Photomultipliers, Resistive Plate Chambers (RPC) and Thick Gaseous Electron Multipliers (THGEM).

Abstract No: G-3

Production of Radioisotopes in Indian Research Reactors

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Abstract:

Radioisotopes are indispensable tool towards advances in health care, agriculture, industry, water resource management and several other areas of human development. A major area of work at Radiopharmaceuticals Division (RPhD), BARC is production of radioisotopes utilizing research reactors for various applications human healthcare, industry, agriculture etc. The vision of Dr. Homi Jehangir Bhabha placed India at the forefront in production of radioisotopes for peaceful applications more than six decades back. Radioisotope production in India started immediately after the commissioning of APSARA reactor at Trombay, Mumbai in 1956. Radioisotopes such as ^{131}I, ^{32}P and ^{198}Au and ^{24}Na were produced, chemically processed, purified and used in hospitals in India as early as 1958. Commissioning of Dhruva research reactor in 1985 is a major milestone in radioisotope production in India and is currently the main source for radioisotopes used in India. Development of novel radio chemicals for varied applications has been the focus over the years. Radioisotope production by neutron irradiation in Indian research reactors have resulted in availability of large number of important radioisotopes such as ^{192}Ir, ^{99}Mo, ^{131}I, ^{153}Sm, ^{177}Lu, ^{125}I, ^{90}Y etc. that find regular use in nuclear medicine and industries. Production of radioisotopes in India is growing from strength to strength as recent large-scale deployment of ^{177}Lu-based radiopharmaceuticals and its popularity in India is a testimony to this. The presentation describes aspects of production of radioisotopes in Indian research reactors with an aim to ensure its steady availability for societal benefit at affordable cost.

Abstract No: G-4

Affordable Radiopharmaceutical Products Developed in BARC

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Abstract:

Radiopharmaceuticals Division (RPhD) at Bhabha Atomic Research Centre (BARC) is primarily involved in production of reactor produced radioisotopes for a wide spectrum of applications in healthcare and industry. Radiopharmaceuticals, drugs tagged with a radioisotope, play a significant role in modern day healthcare for both diagnosis and therapy of various clinical conditions, and therefore, have direct relevance to the society. Research, development, demonstration and deployment of affordable radiopharmaceuticals for diagnosis as well as treatment of human patients suffering from various diseases, including cancer, have been the primary aim of this Department. Commercial deployment of these affordable radiopharmaceutical products developed in BARC is realised through Board Radiation and Isotope Technology (BRIT). In this regard, a large number of products that include freeze-dried kits for the preparation of diagnostic/therapeutic radiopharmaceuticals as well as ready-to-use therapeutic radiopharmaceuticals are commercially deployed in recent years. ^{177}Lu-labeled therapeutic radiopharmaceuticals have gained immense popularity in recent years with its demand continuously increasing over the past few years. ^{177}Lu-DOTA-TATE for therapy of neuroendocrine tumors and ^{177}Lu-PSMA-617 for therapy of prostate cancer are in routine clinical use in various nuclear medicine centers in our country. Recent introduction of ^{90}Y-labeled therapeutic glass microspheres, BhabhaSphere, as an affordable import substitute for therapy of inoperable liver cancer has been a major achievement. The poster presents a glimpse of various radiopharmaceutical products that are developed and deployed from the Department of Atomic Energy with an aim to provide affordable healthcare to the society.

Abstract No: G-5

Clinical Use of Indigenous Telecobalt machine: 5 Year Institutional experience

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Abstract:

This abstract presents our institution's five-year experience with the Bhabhatron II Tungsten Asymmetric motorized Wedge (TAW), an IEC (60601-2-11) compliant indigenous teletherapy machine that employs Cobalt-60 for cancer treatment. Designed to provide cost- effective and low-maintenance radiotherapy solutions, the Bhabhatron II TAW has demonstrated efficacy in addressing a wide spectrum of cancer care needs, including both curative and palliative treatments. Our analysis covers patient demographics, treatment protocols and quality assurance (QA) practices. The machine has been particularly effective in delivering palliative care, significantly improving the quality of life for patients with advanced cancer. Additionally, its role in curative treatment has contributed to favourable disease management and remission rates in a variety of cancers. Despite initial technical challenges, which were swiftly resolved, the overall performance of machine led to enhanced treatment outcomes and heightened patient safety. The Bhabhatron II TAW's affordability and minimal maintenance make it a valuable option for resource- limited settings, broadening access to cancer care. This poster highlights the machine's role in advancing radiotherapy and underscores the importance of indigenous technology in expanding access to effective cancer treatment across underserved regions.

HUMANITIES

Abstract No: H-1

Nuclear Energy and Climate Resilience: Addressing Sea-Level Rise

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Abstract:

Sea-level rise, induced by climate change, poses significant threats to the coastal regions through erosion, flooding, habitat loss, and migration. This phenomenon is primarily caused by melting glaciers and the thermal expansion of seawater. This study aims to demonstrate how nuclear energy, as a low-carbon power source, contributes to climate resilience by reducing CO_2 emissions, thereby helping to mitigate sea-level rise. The objectives are to illustrate nuclear energy's role in lowering CO_2 emissions and to highlight the risks posed by sea-level rise to coastal areas and nuclear plants. The study specifically focuses on the case of *Satabhaya*, Odisha. The methodology involved a comprehensive review of climate and energy data from sources such as the IPCC and IAEA, a case study of *Satabhaya*, Odisha, which demonstrates the impacts of sea-level rise on local communities. It also includes a risk assessment of coastal nuclear plants to evaluate their vulnerability to rising sea levels and extreme weather events. The findings emphasize the importance of incorporating nuclear energy into climate resilience strategies while ensuring the protection of vulnerable populations.

Abstract No: H-2

Carbon Taxes and Energy Transition in India

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Abstract:

The Government of India has imposed carbon taxes on coal, withdrawn petrol and diesel subsidies, and subsidized cleaner energy sources. Moreover, India pledged to reduce carbon emissions through the Paris Agreement 2015. In this paper, we have examined the effect of carbon taxes, the withdrawal of fossil fuel subsidies, and India's signing of COP21 (21st Conference of Parties) on India's energy transition. By using time series regression analysis, we examine the influences of confounding factors, namely the Gross Domestic Product (GDP) of India, international crude oil price, energy intensity of GDP, and India's signing of the Paris Agreement, and examine how the imposition of carbon taxes and withdrawal of petroleum subsidies have influenced the composition of India's energy basket which is measured through the share of fossil fuels in India's energy basket. We used an Autoregressive Distributed Lag (ARDL) model, which has the advantages of joint estimation of short- and long-run dynamics, to test the role of each variable in explaining the energy transition. We observe an inverted-U-shape relationship between GDP and the share of fossil fuels in the energy basket. The imposition of Carbon taxes, subsidy removal from fossil fuels, and clean energy incentives have reduced fossil fuel share. The Paris Agreement has also hastened the shift to cleaner energy. However, the government may impose an ad valorem tax instead of a lump sum tax on coal. The study is significant in light of COP 28's call to move away from fossil fuels.

Keywords: Fossil fuel, Energy, GDP, Paris Agreement, Coal Cess, Time Series

JEL Code: Q35, Q42, E10, Q58, Q58, C10

PURCHASE AND STORES

Directorate of Purchase and Stores

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Abstract:

Directorate of Purchase and Stores is the centralized agency responsible for materials management functions of units under DAE, such as BARC, RRCAT, IGCAR, VECC, NFC, NRB, HWB, BRIT, AMD and DCSEM. Medicines for DAE hospitals all over India are also procured through DPS. In line with General Financial Rules of India, 100% procurement must be done through Government e-Marketplace portal. Due to the sensitive, specific and unique nature of requirements of the units under DAE, standardized procedures are followed for all procurement in DPS. Government e-Marketplace, an end-to-end SPV offers an elegant solution through various bidding modes and standardized modes of procurement from tender stage till payment is done, all digitally and in public domain. In view of Amritkal 2047, Directorate of Purchase and Stores has put forward a seven step Chintan Shivir goal set to achieve the targets of Digital India, including implementation of a single portal software for all purposes of procurement and realization of well-defined standard formats.

परमाणु ऊर्जा विभाग

Department Of Atomic Energy

सत्यमेव जयते