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Bengaluru 560 080

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8–10 November, 2024

Host/Venue:

8–9 November 2024

National Institute of Science Education and Research, Bhubaneswar

Co-host:

10 November 2024

Indian Institute of Technology, Bhubaneswar

ABSTRACTS OF LECTURES

Contents

Friday, 8 November 2024
09:30–11:00 h

Session 1A: Inaugural Session and Presidential Address

Sensing Vibrations using Quantum Geometry of Electrons

After introducing basic ideas of quantum geometry of electronic structure of a crystal, we present a theoretical proposal of a new class of spectroscopies that connect with the ideas in Raman's work (1924) and Pancharatnam's work (1956).

We show that the coupling of phonons with electrons can have nontrivial consequences for the quantum geometry of an electronic structure, which manifests as oscillations in the Berry curvature dipole and hence have observable nonlinear Hall signatures. Using these, we introduce a vibrational spectroscopy based on the geometry of quantum electronic structure (GQuES) making specific predictions for the transport and radiative GQuES spectra of two-dimensional materials. The selection rule presented here for the GQuES activity of a phonon allows the measurement of acoustic and optic phonons spanning sub-GHz, THz, and infrared frequencies, and is readily generalized to other dynamical excitations. GQuES can be used even for materials having trivial quantum electronic geometry, such as hexagonal boron nitride, through a proximal interaction with substrates such as graphene.

Work done in collaboration with R Bhuvaneswari and M M Deshmukh.

Speaker's Profile

Umesh V Waghmare
President, Indian Academy of Sciences (IASc), Bengaluru

Umesh V Waghmare graduated with an Institute Silver Medal and a B.Tech. in Engineering Physics (1990) from IIT-Bombay. He received a Ph.D. in Applied Physics from Yale University, New Haven in 1996 and has carried out postdoctoral research at Harvard University (1996–2000). He joined JNCASR as an Assistant Professor in 2000. He was an Adjunct Professor at Birck Nanotechnology Center of Purdue University (2010–2012) and TIFR, Mumbai (2014–2017). He is currently a Professor in the Theoretical Sciences Unit, JNCASR (2009–present).

Friday, 8 November 2024
11:20–13:30 h

Session 1B: Symposium on "100 years of Raman Spectroscopy – Lab to Life"

11:20–11:25
Introduction by the Convener: S Umapathy

Friday, 8 November 2024
11:25–11:55 h
Session 1B

A Journey of Raman Spectroscopy from Physics to Biology

The talk will give a brief historical perspective of Raman spectroscopy (RS) from discovery to how RS is transforming research. RS, when discovered, was a physics tool, but over time, it has entered into various other disciplines due to its ease of use and non-destructive nature. It can be used on samples in as-is conditions, hence it is becoming an important tool in biology. Many of the applications in biology are hindered by the weak Raman scattering due to small quantities of samples, hence the use of coinage metal nanoparticles was necessitated. This was the genesis for surface-enhanced Raman spectroscopy (SERS). The talk will give a brief introduction to SERS, followed by demonstrating the use of it in biology. One application is protein structure–function studies, important for understanding proteins, drug discovery, etc. SERS combined with MD simulations makes it complementary to X-ray diffraction studies. Here we will be looking at protein aggregation in lysozyme, to understand neuro-degenerative diseases. Another application is in detecting single nucleotide polymorphism, insertion, and deletion sequences in DNA and RNA. As an example, we provide an example of helping farmers in seed selection to avoid crop failures due to diseases. Overall, the talk will provide the audience with 96 years of Raman spectroscopy transforming science in general.

Speaker's Profile

Chandrabhas Narayana
Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram

Chandrabhas Narayana received his Ph.D. in Physics from the Indian Institute of Science (IISc), Bengaluru, in 1995. He specializes in Raman spectroscopy. Though a trained condensed matter physicist, he developed a keen interest in biology within a few years at JNCASR. His group is a pioneer in the use of Raman spectroscopy in (a) drug-protein interaction, for drug screening applications and (b) diagnostic applications. Many of his researches in these areas are trendsetters in inter-disciplinary research. Along with his interest in biology, he also follows his interest in physics and chemistry. Overall, his group has been one of the well-known groups in the country for the use of Raman spectroscopy in the areas of physics, chemistry and biology. He is currently Director of the Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram. He was elected Fellow of IASc in 2018.

Friday, 8 November 2024
11:55–12:25 h
Session 1B

Ultrafast Dynamics, Security Applications, and Impact of Artificial Intelligence

Recent advances in technology have enabled Raman scattering applications from experimentally observing time-dependent atomic movements during vibration to developing portable/tabletop spectrometers for medical diagnosis and security. In this talk, we will share our recent molecular dynamics studies using femtosecond time-dependent Raman spectroscopy. Further we will demonstrate the impact of artificial intelligence and Raman spectroscopy to accurately detect dangerous materials hidden in containers to help security forces and also medical diagnosis of diseases based on scattering measurements on body fluids.

Speaker's Profile

S Umapathy
IISc, Bengaluru

S Umapthy is an Associate Faculty Member with the Department of Instrumentation and Applied Physics, IISc. He is also the Chairman of the Department of Inorganic and Physical Chemistry, IISc and an Honorary Professor at the University of Nottingham, UK. His research interests are instrumentation development, microspectroscopy, laser spectroscopy, photochemistry and ultrafast dynamics. He was elected Fellow of IASc in 2004.

Friday, 8 November 2024
Time: 12:25–12:55 h
Session 1B

Raman Theranostics: Perspectives and Challenges

Optical theranostics, alternatively or interchangeably also referred to as optical pathology, optical biopsy and spectral diagnosis, describe applications of spectroscopic and/or optical-based methods in disease diagnosis and management. Conventionally, diseases are diagnosed by clinical examination followed by relevant biochemical/microbiological/pathological/imaging examinations, which rely on symptomatic manifestations, often leading to late diagnosis and, in turn, poor prognosis. Since biochemical changes precede morphological/symptomatic changes, optical spectroscopies, which are sensitive alterations in chemical compositions, are emerging as potential alternatives/adjuncts. Major attributes of these methods are less time consuming, do not involve external labelling or sample processing, are more objective, and most importantly, involve *in vivo*/*in situ* online diagnosis. Laser-induced fluorescence, FTIR, Raman and diffuse reflectance are some well-known optical methods. The present talk discusses our studies on applications of Raman spectroscopy tools towards disease diagnosis and therapeutic monitoring.

Speaker's Profile

C Murali Krishna
Advanced Centre for Treatment Research & Education in Cancer (ACTREC), TMC, Navi Mumbai

C Murali Krishna received his Ph.D. from the Saha Institute of Nuclear Physics, Kolkata, India. His research interests are in the evaluation of laser Raman spectroscopic methods involved in *in vivo*/*in situ* applications under clinical conditions (optical spectroscopy).

Friday, 8 November 2024
Time: 12:55–13:25 h
Session 1B

Understanding Protein Folding Using Raman Spectroscopy

Proteins are complex three-dimensional structures vital for almost every biological process. It is the characteristic 3-D shape which imparts their specific biological activity. Even small changes in the environment of proteins can lead to protein misfolding. A misfolded protein is not only biologically inactive but may also impose serious health complications as well. Many misfolded proteins are associated with life-threatening diseases such as Alzheimer's, Parkinson's, Huntington's diseases, etc. To reduce the events of misfolding, understanding the mechanism of protein folding is very important. Misfolded proteins undergo structural alterations that cause them to lose their function through different stages. Examining these partially unfolded protein states is key to understanding the protein folding mechanism. Despite various techniques, the protein folding process remains enigmatic. Raman spectroscopy provides valuable insights into protein structure and changes in conformation. By analyzing Raman spectra, we can differentiate between secondary structures such as helices and beta-sheets, as well as identify specific amino acid residues like tyrosine and tryptophan. In our investigation, we compared bovine serum albumin (BSA) proteins based on their distinct sequences and structures. Although determining a protein's complete structure from a Raman spectrum is challenging, Raman spectroscopy can detect subtle alterations in proteins, such as BSA, during melting. Our research underscores the importance of advancements in Raman spectroscopy for unravelling the complexities of proteins.

Speaker's Profile

Nikki Kuhar
Indraprastha College for Women,
University of Delhi, Delhi

Nikki teaches environmental studies to graduate students at Indraprastha College for Women, University of Delhi. Prior to joining here, she taught physical chemistry/quantum chemistry at both graduation and post-graduation levels at the University of Delhi. She obtained her Ph.D. from IISc, Bengaluru, under the supervision of Prof. Umapathy, her Master's from IIT-Bombay and she graduated from St Stephen's College, University of Delhi. Her research includes exploring the biophysical properties of proteins and tissues using vibration spectroscopy. Currently, she is working on characterizing the microplastics and amounts of microplastics present in various types of water sources available in Delhi.

Friday, 8 November 2024
14:30–15:10 h
Session 1C: Special Lecture

Chairperson: Umesh V Waghmare, JNCASR, Bengaluru

Overcoming an Age-Old Thermodynamic Puzzle in Micro-Heat Engines

A heat engine, a device to convert thermal energy to mechanical energy, has been a triumph of our understanding of classical thermodynamics over the last three centuries. In recent years, taking the heat engine concept to a mesoscopic scale, necessarily dominated by fluctuations, has led to the development of stochastic thermodynamics. The experimental realization of these engines in the past decade has helped advance our understanding of heat-to-work conversion at mesoscopic length scales and has offered a glimpse into the functioning of molecular motors and machines. Stochastic heat engines present us with an opportunity that is practically impossible to realize in their macroscopic counterparts.

Observations on engines driven by equilibrium reservoirs for the last decades have led to an understanding that such engines trade off efficiency to operate at finite power – a hypothesis vital to optimising the performance of all man-made machinery. I will discuss our recent work [1] that has cracked this age-old thermodynamic puzzle. We have experimentally established that by engineering the non-trivial coupling between the working substance and the bath, micro-heat engines can achieve both high efficiency and high power simultaneously. I will discuss how such couplings can be brought about and how they feed into the operation of colloidal heat engines. This will include our work related to engines driven by active and non-equilibrium reservoirs with extremely high-performance coupled engines working cooperatively to extract more work and the visco-elastic reservoirs [2,3,4].

References

[1] S. Krishnamurthy, R. Ganapathy and A. K. Sood, *Nature Comm.* **14**, 6842 (2023).
[2] N. Roy, A. K. Sood and R. Ganapathy, *Phys. Rev. Lett.* **131**, 238201 (2023).
[3] S. Krishnamurthy, R. Ganapathy and A. K. Sood, *Soft Matter* **1B**, 7621 (2022).
[4] N. Roy, N. Leroux, A. K. Sood and R. Ganapathy, *Nature Comm.* **12**, 4927 (2021).

Speaker's Profile

A K Sood
IISc, Bengaluru

Ajay Kumar Sood has been the Principal Scientific Advisor to the Government of India (PSA to GoI) since April 2022 and also the Chairperson of the Prime Minister's Science, Technology & Innovation Advisory Council (PM-STIAC). He is also a National Science Chair Professor at the Indian Institute of Science (IISc), Bengaluru. He was a member of the Prime Minister's Science, Technology, and Innovation Advisory Council (PM-STIAC) from 2018 to March 2022 and from 2009 to 2014, he also served as a Member of the Scientific Advisory Council (SAC) to the Prime Minister of India. He has a Doctorate in Physics from IISc, Bengaluru. His research interests include the physics of quantum materials and soft and active matter. He has published over 450 papers in peer-reviewed journals and holds several patents. He was elected Fellow of IASc in 1991.

Friday, 8 November 2024
15:30–16:10 h
Session 1D: Lectures by Fellows/Associates

Chairperson: S Sivaram, IISER, Pune

Friday, 8 November 2024
15:30–15:50 h
Session 1D

Distinguished Representations

Distinguished representations are the central objects in the relative Langlands programme in number theory. This talk will attempt to give a flavour of the subject without getting into technical details.

Speaker's Profile

U K Anandavardhanan
IIT Bombay, Mumbai

U K Anandavardhanan did his B.Sc. from the University of Calicut in 1996 and M.Sc. and Ph.D. from the University of Hyderabad, respectively, in 1998 and 2003. He was a Visiting Fellow at TIFR Mumbai from 2003–2005 and has been a faculty at IIT-Bombay since July 2005. He was elected Fellow of IASc in 2024.

Friday, 8 November 2024
Time: 15:50–16:10 h
Session 1D

Artificial Intelligence for End-to-End Materials Modeling and Discovery

Materials form the backbone of society. Traditional materials discovery relies on trial-and-error approaches, thereby leading to a design-to-deployment period of 20–30 years. To address this challenge, we will discuss the application of artificial intelligence (AI) and machine learning (ML) in accelerating materials modeling and discovery. Specifically, we propose how an end-to-end AI-driven framework can enable filtering the design space, identify potential candidates with target properties, and then finally test them. To this end, a three-step framework is proposed, including (i) materials-aware large language models for information extraction and candidate selection, (ii) in-silico modeling and design of materials, and (iii) automated experiments driven by large language models (LLMs). Through several examples, we will discuss how AI and ML have made tractable some of the challenging problems in materials and mechanics in particular and the scientific domain in general. We will also discuss how physics-based inductive biases can be leveraged along with data-driven models. Finally, we will discuss some of the outstanding problems in the domain to accelerate real-world materials discovery.

Speaker's Profile

N M Anoop Krishnan
IIT-Delhi, Delhi

N M Anoop Krishnan is an Associate Professor in the Department of Civil Engineering, IIT-Delhi with a joint appointment in the Yardi School of Artificial Intelligence. He completed his Ph.D. in Civil Engineering from the Indian Institute of Science Bengaluru in 2015, after which, he worked as a postdoctoral researcher at the University of California, Los Angeles from 2015 to 2017. He completed his B.Tech. in Civil Engineering from the National Institute of Technology, Calicut, in 2009. He works at the intersection of materials, mechanics, simulations, and AI and ML to accelerate materials modelling and discovery. He has published more than 100 international peer-reviewed journal publications and has 2 granted patents. He has founded a start-up: Substantial AI Pvt. Ltd, incubated at IIT Delhi, for AI-driven materials discovery and process optimization. He has won several awards including the Humboldt Fellowship (2023) for experienced researchers, Google Research Scholar Award (2023), W A Weyl International Glass Science Award by ICG and Penn State University (2022), Indian National Academy of Engineering Young Engineer Award (INAE YAE 2020), BRNS-DAE Young Scientist Award (2021), and National Academy of Science India Young Scientist Award (NASI YSA 2021). He was selected Associate of IASc in 2022.

Friday, 8 November 2024
16:40–17:20 h
Session 1E: Lectures by Fellows/Associates
Chairperson: Saraswathi Vishveshwara, IISc, Bengaluru

Friday, 8 November 2024
Time: 16:40–17:00 h
Session 1E

Was NASA's Microgravity Experiment on Material Coarsening Ill-Planned? Insights from AI-Assisted Materials Research

The properties of two-phase materials, consisting of a matrix and a precipitate, depend on the volume fraction and size distribution of the latter. However, under suitable conditions, the average precipitate size increases over time to reduce the overall interface energy of the system. Given the resulting changes in properties, efforts are made to understand and predict the temporal evolution of the precipitate. A foundational theory captures the kinetics of this coarsening evolution through critical assumptions [1]. NASA sought to validate and extend this theory by analyzing the microstructural evolution of a Pb–Sn solid–liquid system in microgravity, ensuring the underlying assumptions were met [2]. While initial investigations suggested that the Pb–Sn system followed the established theory, further AI-assisted analyses revealed that the system evolved through an unexpected mechanism. These analyses identified trans-interface diffusion as the primary factor controlling the kinetics of microstructural evolution in the Pb–Sn solid–liquid system, as opposed to the migration of chemical species in the matrix [3]. As a result, the volume fraction of the precipitate showed no consistent effect on the coarsening kinetics.

References

[1] Voorhees P. W., 1985. The theory of Ostwald ripening, *Journal of Statistical Physics*, **38**, 231–252.
[2] Snyder V. A., Alkemper J. and Voorhees P.W., 2001. Transient Ostwald ripening and the disagreement between steady-state coarsening theory and experiment, *Acta Materialia*, **49**, 699–709.
[3] Ardell A. J. and Ozolins V., 2005. Trans-interface diffusion-controlled coarsening, *Nature Materials*, **4**, 309–316.

Speaker's Profile

P G Kubendran Amos
National Institute of Technology, Tiruchirappalli

Kubendran Amos is an Assistant Professor in the Department of Metallurgical and Materials Engineering at the National Institute of Technology, Tiruchirappalli. He completed his doctoral studies in the computational materials science group at the Karlsruhe Institute of Technology, Germany, where he also served as a postdoctoral scientist. His research primarily focuses on the theoretical modelling of material behaviour at the microscopic scale and integrating advanced artificial intelligence techniques to quantify the outcomes.

He and his team are at the forefront of employing machine learning-based computer vision techniques to investigate the kinetics of spatio-temporal evolution in materials. Their recent work aims to develop microstructural fingerprints that correlate processing conditions with material properties, advancing the understanding of material behaviour and enhancing predictive capabilities in materials engineering. He was selected Associate of IASc in 2023.

Friday, 8 November 2024
17:00–17:20 h
Session 1E

Understanding the Social Language of Bacteria: Speak or Not to Speak?

Bacteria coordinate their social behaviour in a density-dependent manner by the production of diffusible signal molecules via a process known as quorum sensing (QS). Sensing and adaptation to changing environmental conditions were traditionally attributed to two-component sensors and response regulators. The increasing volume of work now suggests that the coordination of responses to fluctuating environments is very complex, as many microbial species live in communities under natural conditions. We are using the *Xanthomonas* and *Pseudomonas* group of plant pathogens which make diverse quorum-sensing signalling molecules to address the mechanism of integration and adaptation to changing environmental conditions. Our work has shown that fine-tuning of QS regulatory circuits in closely related members of the *Xanthomonas* group of phytopathogens contributes to their lifestyle change inside the host. We are also trying to understand how QS-mediated social structure and individuality in the bacteria coexist to improve their fitness in fluctuating environments. Our interest is also in understanding the mechanism by which bacterial pathogens could integrate cell density signalling, host response and environmental signal to coordinate virulence and regulation of gene expression.

Speaker's Profile

Subhadeep Chatterjee
Centre for DNA Fingerprinting and Diagnostics (CDFD),
Hyderabad

Subhadeep Chatterjee obtained his M.Sc. degree in Biotechnology from Guru Nanak Dev University, Amritsar in 1998. He completed his Ph.D. in CCMB, Hyderabad. During his Ph.D. work, he identified and characterized two novel virulence functions of an economically important pathogen of rice. In 2005, he joined Prof. Steven E Lindow's group at the University of California, Berkeley, to pursue a more complex plant–microbe interaction system that also involves an insect vector for transmission of the bacterial pathogen *Xylella fastidios*a in several economically important plants like grape, almond, citrus. In his postdoctoral work, he characterized a fatty acid-like extracellular signalling molecule in *Xylella fastidiosa*. In the applied part of his postdoctoral work, he made transgenic plants that can express the bacterial quorum sensing signalling molecules and were reduced in severity of disease. He also characterized several plant-associated bacteria that can degrade pathogen signalling molecules and, hence, can suppress their virulence in host plants. He was elected Fellow of IASc in 2023.

Friday, 8 November 2024
18:00–19:00 h
Session 1F: Public Lecture
Chairperson: Umesh V Waghmare, JNCASR, Bengaluru

Participatory Governance and the Need to Promote and Nurture Active Citizenship

Participatory governance plays a significant role in enhancing democracy by engaging citizens as active participants in decision-making processes. Central to this approach are four key pillars: participation, transparency, accountability, and inclusion.

Participation empowers citizens to participate in governance through public consultations or participatory budgeting, ensuring their voices shape policies that affect their lives. Transparency fosters trust between citizens and governments, as open communication about decisions and actions reduces corruption. Accountability holds public officials responsible for their actions, ensuring that governance aligns with citizens' needs. Lastly, inclusion guarantees that marginalized communities have a seat at the table, promoting equity in governance.

The role of science and technology is critical as a powerful tool for enhancing civic engagement and fostering transparency through digital platforms and e-governance. However, challenges such as social inequalities and civic apathy persist, necessitating strategies that include civic education and reforms to encourage active citizenship.

Ultimately, there is a need for collective action to create a more inclusive, transparent, and accountable governance system that reflects the diverse needs and aspirations of all citizens, empowering individuals to engage meaningfully in their communities.

Speaker's Profile

Shri Jagadananda
Centre for Youth and Social Development, Bhubaneswar

Shri Jagadananda leads the Centre for Youth and Social Development (CYSD), an autonomous development organization working with the tribal and rural poor in Odisha with an aim to realize the goal of people-centered equitable development. Sustainable rural livelihoods, participatory governance and community-based disaster resilience are amongst the major areas of work of the Centre in his journey over the last four decades. He held office as the State Information Commissioner, Odisha, to advance the right to information (RTI) agenda in the State and was a Member of the State Planning Board, following his active campaigning for people-centric decentralized planning. He was a Member of the Standing Committee (CSOs) at NITI Aayog on institutionalizing partnership between Civil Society and the Government.

He has held office as Chairperson, Voluntary Action Network India (VANI), the Chair of Credibility Alliance and the Chair of Sa-Dhan, a national network of community development micro finance institutions.

He was a senior visiting fellow at CIVICUS – World Alliance for Citizen Participation, and worked on issues of legitimacy, transparency and accountability within civil society at the Kennedy School of Government at Harvard University, Cambridge, USA. His publication '*Civil Society Legitimacy and Accountability*' is widely available in French, Spanish, Arabic and English.

Saturday, 9 November 2024
09:00–10:30 h
Session 2A: Lectures by Fellows/Associates

Chairperson: Vinod K Gaur, Bengaluru

Saturday, 9 November 2024
09:00–09:20 h
Session 2A

Polar Warming and Tropical Teleconnections

The polar regions are a critical component of the Earth's climate system and have complex, non-linear linkages with low latitudes through the ocean and atmosphere. They are also very sensitive to global changes. While both the Arctic and West Antarctica have experienced dramatic changes in recent decades during a time of increasing global mean temperature, the relative roles of local versus remote forcings on such changes are not well understood. In a rapidly changing world, the two-way linkages between the poles and tropics can play key roles in the climatic evolution of these sensitive regions. Such tropical–polar teleconnections operate on a range of timescales and are found to have a dominant role through Rossby wave dynamics. Recent studies have highlighted that a rapid decline in Arctic sea-ice during the recent decade is increasing extreme precipitation events over India. Studies have also revealed that Antarctica is witnessing an increased frequency of extreme events and incursions of Atmospheric Rivers (AR) that have the potential to increase the loss of coastal ice shelves, impacting the health of its huge ice sheets. Although recent studies have contributed greatly to our understanding of polar–tropical teleconnections, many aspects of these linkages remain poorly understood and require further study using a combination of observational, model, and proxy-based climate records.

Speaker's Profile

Thamban Meloth
National Centre for Polar and Ocean Research (NCPOR), Goa

Thamban Meloth is the Director of NCPOR under the Ministry of Earth Sciences, Government of India. He has made pioneering contributions to polar and cryosphere studies in India and was instrumental in establishing India's first state-of-the-art Ice Core Laboratory at NCPOR. His research primarily focuses on climate variability and its impact on polar ice sheets and glaciers. He has undertaken multiple scientific expeditions to challenging and remote areas of Antarctica, the Arctic, the Himalayas, and the Southern Ocean.

He has been received many recognitions for his scientific contributions such as the prestigious National Geoscience Award by the Government of India. He is a Fellow of the National Academy of Sciences, and the Norwegian Scientific Academy for Polar Research (NVP). He is also a member of various national and international committees and panels of the World Meteorological Organization (WMO), World Climate Research Programme (WCRP), Scientific Committee on Antarctic Research (SCAR), and International Arctic Science Committee (IASC) Council. He was elected Fellow of IASc in 2024.

Saturday, 9 November 2024
Session 2A
09:20–09:40 h

Redox Dynamics in Health and Disease: Pathways from Inorganic Chemistry to Therapeutic Innovation

In the realm of scientific exploration, biological inorganic chemistry stands as a burgeoning frontier. Our research consortium is dedicated to the pioneering development of molecules and materials poised to exert a positive influence on human health. Employing an innovative approach grounded in modern inorganic, organometallic, supramolecular, and nanomaterials chemistry, our focus revolves around the strategic conception and fabrication of novel metal-based drugs. These compounds are meticulously designed to wield the transformative power necessary to perturb cellular metal trafficking and homeostasis, thereby fortifying our armamentarium against emergent pathogens and infections. Central to our endeavour is a profound emphasis on unravelling the intricate dynamics of metal–ligand interactions, fuelling our pursuit of site-selective drug discovery. As the scientific landscape burgeons with investigations into metalloenzymes and coordination chemistry, a novel platform is being forged—one that harnesses the potential of metal-biologically relevant ligand interactions to usher in a new era of therapeutic interventions. Our focus spans a spectrum of ailments, encompassing neurodegenerative disorders, cancer, metabolic or autoimmune syndromes, and microbial infections.

Ritika's lab unfolds with precision, encompassing key facets: (a) the design and synthesis of pharmaceutically relevant drugs driven by the dynamics of metal–ligand interactions, (b) the creation of transition metal complexes endowed with the potential for biological processes such as electron transfer, small molecule catalytic activation, and redox sensing, (c) the exploration of novel applications for these ligands and metal complexes in therapeutics, diagnostics, immune modulation, anion recognition, and metal ion sensing, and (d) the judicious utilization of proteomics and metabolomics profiles to elucidate the mechanism of action and identify the precise target site.

In this pursuit, our scientific expedition converges at the intersection of cutting-edge research and translational impact, visualizing a future where the coordination of metal-based interventions directs a symphony of therapeutic and diagnostic potential across diverse realms of human health.

Speaker's Profile

Ritika Gautam Singh
IIT-Kanpur

Ritika was born and raised in Azamgarh, a town in the eastern Uttar Pradesh, India. She received her B.Sc. (Hons) and M.Sc. degrees in chemistry from Banaras Hindu University and the Indian Institute of Technology Delhi, respectively. In 2012, she relocated to the United States to pursue doctoral studies at the University of Arizona, followed by a research associate position at The Scripps Research Institute, La Jolla, California. In September 2019, Ritika returned to India to establish her independent research group at IIT-Kanpur. Her group focuses on engineering metal-based diagnostics and therapeutics at the interface of biological inorganic chemistry, synthetic immunotherapy, and medicinal chemistry. Ritika has received notable early-career recognitions, including being named a Royal Society of Chemistry Emerging Investigator and an American Chemical Society Rising Star in 2023. Ritika was selected Associate of IASc in 2024.

Saturday, 9 November 2024
Session 2A
09:40–10:00 h

Cannabis Therapeutic Potential in Neurodegenerative Diseases

Common neurogenerative diseases include Alzheimer's Disease (AD), Parkinson's Disease (PD), and Amyotrophic Lateral Sclerosis (ALS), which have a significant impact on health globally. These diseases are primarily characterized by deterioration of neurons and a decline in cognitive and motor functions. The major identified mechanisms include oxidative stress, mitochondrial dysfunction, apoptosis, neuroinflammation, dysregulation of protein degradation through autophagy, and gut dysbiosis. These complications in pathogenesis impose great challenges in targeted drug discovery. The phytochemicals isolated from *Cannabis sativa* have received attention as potential therapeutic molecules for neurological disorders. Although around 125 cannabinoids have been identified and studied for their biological activities, the pharmacological investigation of other molecules has not been studied, and their therapeutic potential is still unknown. In our recent research, we investigated the neuroprotective activities of non-cannabinoid molecules, spiroindanes, in neuronal cell lines. Some spiroindane molecules showed a potential neuroprotective effect via alleviation of oxidative stress, apoptosis, and mitochondrial dysfunction, and further mechanistic studies were explored in suitable *in vivo* models for their therapeutic activities. The phytoconstituents of cannabis can be explored for their neuroinflammation and neuroprotective properties to identify potent therapeutic molecules for neurodegenerative disease.

Speaker's Profile

Ramajayan Pandian
Indian Institute of Integrative Medicine (IIIM), Jammu

Ramajayan Pandian is currently working in CSIR – IIIM as a scientist. He completed his B.VSc. and A.H. at Pondicherry University in 2014 and did his M. VSc. at Madras Veterinary College, Chennai, in 2016. He is an experienced veterinarian and scientist with exposure in the area of pre-clinical research. He is skilled in conducting laboratory animal research for exploratory and regulatory studies in the pre-clinical research environment. His research includes genetic monitoring and molecular characterization of inbred, outbred, transgenic, and immunocompromised animal models and also in monitoring the health of laboratory animals maintained under specific pathogen-free (SPF) conditions. He was selected Associate of IASc in 2024.

Saturday, 9 November 2024
10:00–10:20 h
Session 2A

Some Explorations into Krylov/Spread Complexity

Motivated by recent progress in understanding quantum chaos through the notion of operator growth, we explore some applications of Krylov complexity/spread complexity for certain quantum many-body systems and probe their dynamics (in both open and closed setups) through the complexity and see what interesting lesson we can learn from this.

Speaker's Profile

Arpan Bhattacharyya
IIT-Gandhinagar

After completing a Ph.D. from the Centre for High Energy Physics at the Indian Institute of Science, Bengaluru, in 2015, Arpan joined as a postdoctoral fellow at Fudan University, China. He was a JSPS Postdoctoral Fellow at the Yukawa Institute for Theoretical Physics at Kyoto University, Japan. Presently, he is an Assistant Professor in the Physics Department of IIT-Gandhinagar. His research interests include the application of quantum information in quantum many-body systems and quantum gravity (AdS/CFT), as well as understanding gravitational wave physics through the lens of scattering amplitude. He was selected Associate of IASc in 2023.

Saturday, 9 November 2024
10:50–13:00
Session 2B: Symposium on "Neurocircuits Governing Behavior"

10:50–10:55
Introduction by the Convener: Vidita Vaidya

Saturday, 9 November 2024
10:55–11:25 h
Session 2B

Neuropeptides in Generating Stable Innate States: Modulating the Feeding Drive

Innate states drive survival behaviours, though their neural implementation is poorly understood. Mechanisms mediating switching between alternative circuit states are critical for behaviour selection, while behavioural stability depends on the maintenance of reconfigured innate states. In the context of the feeding drive, internal energy demands drive the reconfiguration of neuronal circuits to adaptively regulate feeding behaviour. Energy state-dependent neuropeptide release from interoceptive neurons can signal energy status to feeding-associated circuits and modulate circuit function. The neuropeptides CART and NPY are major anorexic and orexic factors, respectively, but the intracellular signalling mechanisms utilized by these peptides to alter circuit function remain uncharacterized.

Using a zebrafish model, we show that glucose-responsive peptidergic neurons of the hypothalamus and ventral telencephalon converge onto the dorsomedial telencephalon (Dm) and modulate its activity by antagonistic CART and NPY signalling. In addition, CART-induced positive feedback temporally extends the hyperexcitable state of the Dm neurons, resulting in temporally stable changes in the feeding drive. These studies reveal novel modes of circuit modulation critical for homoeostasis and the generation of stable behavioural outcomes.

Speaker's Profile

Aurnab Ghose
IISER, Pune

Aurnab Ghose completed biology and chemistry at Presidency College, Calcutta, India, followed by a Master's from the University of Leicester, UK. His Ph.D. research was conducted at the Beatson Institute for Cancer Research, UK. Following postdoctoral research at the Department of Cell Biology, Harvard Medical School, USA, he joined the faculty of IISER, Pune, where his group studies the development and function of neural circuits. His lab employs quantitative cell biology, biophysical measurements, activity imaging and behavioural analysis to explore the ontogeny and homoeostasis of neural circuits, with emphasis on cytoskeleton remodeling and cellular biomechanics and the functional modulation of neural circuits by neuropeptides and integration of internal states with behavioural outputs.

Saturday, 9 November 2024
11:25–11:55 h
Session 2B

Mapping the Neurocircuit Responses to a Serotonergic Psychedelic – Relevance to Anxiety

There has been a recent renewal of interest in the therapeutic potential of serotonergic psychedelics. In my talk, I will discuss our recent work mapping the precise neurocircuit that drives the reduction in anxiety-like behavior noted with the serotonergic psychedelic DOI (2,5-dimethoxy-4-iodoamphetamine). We uncover the essential role of ventral hippocampus (vHpc) GABAergic interneurons in the anxiolytic effect evoked by DOI. Integrating anatomical, pharmacological, and genetic approaches, we show that 5-HT2A receptors in the CA1/subiculum (CA1/sub) region of the vHpc are required for the anxiolytic action of DOI. *In vivo* electrophysiology and opto-tagging experiments indicate that DOI enhances the firing rate of hippocampal fast-spiking parvalbumin (PV)-positive interneurons, most of which express the 5-HT2A receptors. Restoration of 5-HT2A receptors in PV-positive interneurons in a loss-of-function background reinstated the anxiolytic responses evoked by DOI in the vHpc CA1/sub-region. Collectively, our results localize the acute anxiolytic action of a serotonergic psychedelic to 5-HT2A receptors in the ventral hippocampus and specifically identify PV-positive fast-spiking cells as a cellular trigger for the psychedelic-induced relief of anxiety-like behavior.

Speaker's Profile

Vidita Vaidya
TIFR, Mumbai

Vidita Vaidya received her undergraduate degree from St. Xavier's College, Mumbai in Life Sciences and Biochemistry. She obtained her Ph.D. in Neuroscience at Yale University in the lab of Prof. Ronald Duman. Her postdoctoral work was done at the Karolinska Institute in Sweden with Prof. Ernest Arenas and at the University of Oxford in the UK with Prof. David Grahame-Smith. She joined the Department of Biological Sciences, TIFR, as a faculty member in March 2000. Her research group's work has been recognized by the National Bioscientist Award in 2012, the Shanti Swarup Bhatnagar Award in Medical Sciences in 2015, and the Infosys Prize in Life Sciences in 2022. In 2019, she received the Nature Award for Mentoring in Science in the mid-career category and, in 2021, the JC Bose National Fellowship from the Science and Engineering Research Board (SERB). She is a Fellow of the Indian National Science Academy (INSA), and the National Academy of Sciences, India (NASI), as well as a Distinguished Visiting Professor at the Indian Institute of Technology, Bombay. She is committed to enhancing equity and diversity in academia and working to break down the barriers that prevent academic working environments from being inclusive spaces. She was elected Fellow of IASc in 2021.

Saturday, 9 November 2024
11:55–12:25 h
Session 2B

Uncovering the Links between Hippocampal Spatial Representations, Locomotor Stepping, and Memory

The hippocampus is a key brain structure that expresses spatial representations and is crucial for navigation. Navigation, in turn, intricately depends on locomotion; however, hippocampal spatial representations and the details of locomotor processes are typically investigated separately. Specifically, the hippocampus is thought to represent mainly higher-order cognitive and locomotor variables, whereas the limb movements that propel the animal are thought to be computed and represented primarily in subcortical circuits. In our prior work, we simultaneously monitored hippocampal activity and limb movements underlying locomotion. We found that the forelimb stepping cycle in freely-behaving rats is rhythmic and peaks at around 8 Hz during movement, matching the approximately 8 Hz modulation of hippocampal activity and spatial representations during locomotion. In this symposium talk, I will discuss those results and share some ongoing efforts to disrupt the hippocampal neural activity patterns during locomotion to investigate their effects on learning.

Speaker's Profile

Abhilasha Joshi
National Centre for Biological Sciences (NCBS),
Bengaluru

Abhilasha Joshi is a systems neuroscientist who is an Assistant Professor at NCBS. She has been fascinated by the synchronization of cognition and locomotion in the hippocampus, the part of the brain involved in learning, memory, and spatial representation. She won the Peter and Patricia Gruber International Research Award from the Society for Neuroscience in 2023 for outstanding research and educational pursuit in an international setting for work on the rapid synchronization between internal cognitive representations and the stepping rhythm. She is also a Simons Foundation Fellows-to-Faculty Awardee. After completing her Ph.D. at the University of Oxford, she continued her postdoctoral work on cognition and movement at the University of California, San Francisco, and later in Lisbon, where she was a visiting scientist.

Saturday, 9 November 2024
12:25–12:55 h
Session 2B

Behaviour, Mechanisms and Circuits through the Lens of Gamma Oscillations

Gamma oscillations are high-frequency (30–80 Hz) oscillations in brain signals which are modulated by high-level cognition, such as attention and meditation, potentially offering clues about mechanisms underlying high-level cognition. We study gamma oscillations in both humans and non-human primates while they are engaged in cognitive tasks. I will first discuss how healthy ageing, mental disorders such as Alzheimer's disease (AD), and meditation affect gamma oscillations in humans. I will then discuss how these oscillations can be induced by the presentation of visual stimuli in non-human primates and how the presence of small discontinuities in the stimulus affects these oscillations. Finally, I will describe a simple circuit model which captures these stimulus dependencies, providing important clues about the neural circuits that give rise to gamma oscillations.

Speaker's Profile

Supratim Ray
IISc, Bengaluru

Supratim Ray received a B.Tech. in Electrical Engineering from IIT Kanpur and a Ph.D. in Biomedical Engineering from the Johns Hopkins School of Medicine, USA. He did his postdoctoral training in the Department of Neurobiology at Harvard Medical School with John Maunsell. He joined the Center for Neuroscience in June 2011. His research areas are neural oscillations and high-level cognition.

Saturday, 9 November 2024
14:00–15:50 h
Session 2C: Lectures by Fellows/Associates
Chairperson: Rajesh K Srivastava, BHU, Varanasi

Saturday, 9 November 2024
14:15–14:30 h
Session 2C

Budgeting Heat and Energy: How Do Birds Do It?

Animals face various environmental challenges on a daily basis while foraging for food, managing their thermal needs, and finding safe places to sleep and rear their young. I am especially interested in how they manage their daily energy needs, given these survival and environmental challenges. One way to study this is to measure how animals allocate their daily energy budgets across various activities, such as in different land use types. One potential component of this daily energy budget is the ability to modulate their thermoregulatory costs by using heterothermy, where animals lower their body temperatures to save energy. Hibernation is a form of heterothermy. Birds like hummingbirds can use a daily version of this, called daily torpor, dropping their body temperature by up to 38°C (down to 3°C). I have been studying this adaptation in hummingbirds, integrating ecological data, whole animal energetics, gene expression, and mitochondrial parameters to understand heterothermy across biological scales. I am studying comparative avian heterothermy, by collecting data from the Indian tropics while training local biologists. I plan to continue to integrate ecology, physiology, evolutionary perspectives, and molecular and imaging techniques to understand how heterothermic animals exist.

Speaker's Profile

Anusha Shankar
TIFR, Hyderabad

Anusha Shankar is a Reader/Assistant Professor at TIFR, Hyderabad. She joined in October 2023, and her lab is starting to study the ecology and physiology of birds in Telangana and Arunachal Pradesh. For the past 12 years, she has been studying hummingbirds' energy management strategies in the face of environmental variation. She is especially fascinated by their ability to use a hibernation-like state called torpor to save energy at night. In her latest project, she has been investigating gene expression across metabolic states in hummingbirds: how can they get cold (50°F/10°C) sometimes every night, and rewarm safely every morning, without damaging organs like their hearts and brains? Anusha is also a National Geographic Explorer and Young Leader, a Ramalingaswami Fellow, and a Leading Edge Fellow, and loves mentoring students. She was selected Associate of IASc in 2024.

Saturday, 9 November 2024
14:20–14:40 h
Session: 2C

Unique Applications of Neutron Scattering in Exploring Soft Matter Phenomena

Neutron scattering offers unparalleled advantages in studying soft matter, primarily due to its sensitivity to low-Z elements, which constitute most soft materials, and the ability to probe relevant length and time scales [1–3]. The nuclear interaction between neutrons and atomic nuclei enables the powerful approach of contrast variation through isotopic substitution, unveiling structural and dynamical insight that might otherwise remain inaccessible. Neutron scattering methods are non-destructive, allowing measurement of delicate soft materials under native conditions. Among these methods, small-angle neutron scattering (SANS) is especially utilized for probing structures and interactions at a mesoscopic length scale, which is pertinent in these systems [2,4]. The technique is versatile and applicable to probing a wide range of soft matter constituents, such as colloidal dispersions, self-assembled structures, biomolecules, polymers and their derivatives, liquid crystals, membranes, as well as their complexes. In this talk, I will discuss our recent studies showcasing the utilization of SANS to explore the complex interplay of Deryagin–Landau–Verwey–Overbeek (DLVO) and non-DLVO interactions in some scientifically/technically important phenomena (e.g., re-entrant phase behavior [4–7], nano-bio conjugation [8,9], colloid-polymer interactions [10,11]) in multi-component soft matter systems and resultant structures.

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Speaker's Profile

Sugam Kumar
BARC, Mumbai

Sugam Kumar is a Scientific Officer at the Solid-State Physics Division, Bhabha Atomic Research Centre, and an Assistant Professor at Homi Bhabha National Institute, Mumbai. He earned his Ph.D. from Homi Bhabha National Institute and carried out his postdoctoral research at Stockholm University, Sweden. He is a member of the National Academy of Sciences, India. He has received several prestigious awards, including the NASI Young Scientist Platinum Jubilee Award, the DAE Young Scientist Award, the Indian Physics Association's Best Thesis Award, the Homi Bhabha Prize, and university medals during his graduation and post-graduation. His research interests focus on soft condensed matter, biophysics, and neutron scattering techniques. With more than 100 publications in leading international journals, he has made significant contributions to his field. He was selected Associate of IASc in 2022.

Saturday, 9 November 2024
14:40–15:00 h
Session: 2C

A Tale of Cellular and Metabolic Essential for the Development of Blood Cells

Employing *the Drosophila* blood cell system, we have tried to understand the crosstalk between the stem cell compartments. In this process, we have unravelled several new signals and metabolic cues essential for the maintenance and functionality of the stem cell niche and the blood progenitors.

Our recent work shows how cellular systems can maintain phenotypic stability despite multiple perturbations produced by environmental changes, stochastic events, and genetic diversity. Cues to which a cell needs to respond immediately would specifically utilize mechanisms that can initiate a rapid turnover of the functionally active entities of a cell. One such entity can be the translating mRNA requiring immediate clearance to cope actively with an environmental response triggered by cellular sensing. In this context, we demonstrate that the miRNAs are not mere bystanders but active players in dictating how blood cells react to their environment, particularly in varying nutrient states. Employing *in vivo* (*Drosophila*) and *in vitro* (human primary and blood cell lines), our study establishes the functional association between an environmental signal of nutrient availability and active-miRNA machinery essential for hematopoietic growth and proliferation.

Speaker's Profile

Lolitika Mandal
IISER, Mohali

After completing her PhD at the Cytogenetics Laboratory BHU, under the mentorship of Jagat Kumar Roy, Lolitika Mandal headed for her postdoctoral studies at UCLA, USA. During her time there, she spearheaded research on blood cell development under the guidance of Voker Hartenstein and Utpal Banerjee. In July 2009, she joined IISER Mohali when the institute was in its early stages. With Welcome Trust DBT Intermediate and Senior Fellowships, she established a laboratory of international standards. Her team's primary focus is on understanding the cellular crosstalk between stem cell compartments and unravelling the molecular circuitry essential for cell fate specification and the function of blood cells. Notably, her work using the fruit fly as a model has uncovered several significant similarities with mammalian hematopoiesis. She is a Professor in the Department of Biological Sciences, IISER Mohali and elected member of INSA and NASI. She was elected Fellow of IASc in 2023.

Saturday, 9 November 2024
15:00–15:20 h
Session 2C

Sustainable Synthetic Organic Chemistry on Pharmaceutical Innovation

Tetrasubstituted olefins and heterocycles are fundamental building blocks present in many natural products, pharmaceuticals, agrochemicals, and electron-transport materials. Tamoxifen, a tricyclicethylene moiety, is an important drug candidate.

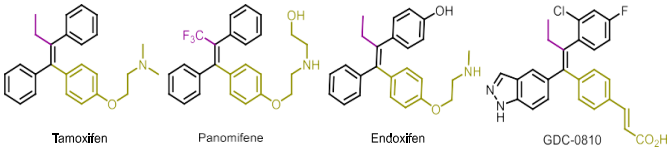

Figure 1. Tamoxifen based drugs.

The regioselective difunctionalization of unsymmetrical alkynes provides facile access to highly substituted olefins, like Tamoxifen. The cyclization and annulation reactions of alkynes offer an attractive means to access various heterocyclic compounds. This multi-component one-pot synthetic protocol could be sustainable and cost-effective when compared with multi-step methods. This presentation will feature strategies to design synthetic routes enabling tetrasubstituted olefins and cyclic heterocycles.

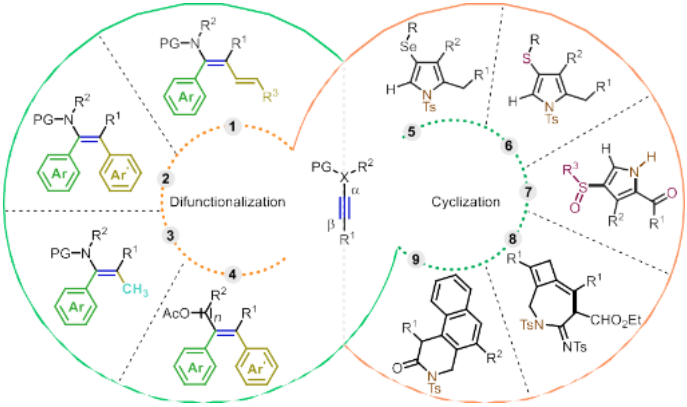

Figure 2. Regioselective difunctionalization and cyclization of internal alkynes.

Speaker's Profile

Akhila Sahoo
University of Hyderabad, Hyderabad

Prof. Akhila Sahoo has been Professor of Chemistry at the University of Hyderabad since 2016. He completed his PhD at the National Chemical Laboratory, Pune, India. He did his postdoctoral research at Kyoto University, Japan. His research interests are transition-metal-catalyzed organic transformations, Lewis-acid-catalyzed organic transformations and high-energy materials. He was elected Fellow of IASc in 2021.

Saturday, 9 November 2024
18:00–19:00 h
Session 2D: Public Lecture

Chairperson: Umesh V Waghmare, JNCASR, Bengaluru

Finding Forgotten Cities – Looking Back at the Discovery of the Indus Civilization

2024 is a century from the year when John Marshall made an announcement that dramatically altered existing perceptions of India's antiquity: the discovery of 'The Civilization of the Indus Valley'. Who were the main protagonists in this discovery saga? Is the story of its discovery similar to how scientific discoveries are made? What was the vision of the Archaeological Survey of India in the early years after the discovery of the antiquity of Harappa and Mohenjodaro? This lecture will look at such questions as it narrates the fascinating story of how India's antiquity was unexpectedly discovered in 1924.

Speaker's Profile

Nayanjot Lahiri
Ashoka University, Sonepat

Nayanjot Lahiri is a Professor of History at Ashoka University since 2016. Her many books include *Pre-Ahom Assam* (1991), *The Archaeology of Indian Trade Routes* (1992), *Finding Forgotten Cities – How the Indus Civilization was Discovered* (2005; centenary edition 2024), *Marshalling the Past – Ancient India and its Modern Histories* (2012), *Ashoka in Ancient India* (2015), *Monuments Matter – India's Archaeological Heritage since Independence* (2017), *Time Pieces – A Whistle-Stop Tour of Ancient India* (2018), *Archaeology and the Public Purpose – Writings on and by M.N. Deshpande* (2021) and *Searching for Ashoka* (2022). She was awarded the Infosys Prize in Humanities – Archaeology for 2013, and her book, "*Ashoka in Ancient India*" won the John F. Richards prize of the American Historical Association for the best book in South Asian History for 2015.

Sunday, 10 November 2024
09:00–10:20 h
Session 3A: Lectures by Fellows/Associates

Chairperson: U C Mohanty, Centre for Climate Smart Agriculture, Bhubaneswar

Sunday, 10 November 2024
09:00–09:20 h
Session 3A

The *Cryptex* called Human Genome

Recent advances in molecular and statistical genetics have enabled the reconstruction of human history by studying DNA from living humans as well as from relics and artefacts. The ability to sequence and study DNA by calibrating the rate of accumulation of changes with evolutionary time has enabled robust inferences about the history and pre-history of anatomically modern humans or *Homo sapiens sapiens*. These data indicate that modern humans evolved in Africa about 250,000 years ago and, consistent with paleontological evidence, migrated out of Africa about 70,000 years ago. Through a series of fission and fusion of populations: settlements, demographic expansions, further migrations, introgression, and admixture, they populated the entire world. One of the first waves of migration 'Out of Africa (OoA)' was into the Indian subcontinent. Subsequent, more recent, waves of migration from other parts of the world have resulted in India being a genetic melting pot. Contemporary India has a rich tapestry of cultures and ecologies. There are about 400 tribal groups and more than 4000 groups of castes and subcastes, speaking dialects of 22 recognized languages belonging to four major language families. The contemporary social structure of Indian populations is characterized by endogamy with different degrees of porosity. The social structure, possibly coupled with large ecological heterogeneity, has resulted in considerable genetic diversity and local genetic differences within India. In this talk, I will discuss the genetic evidence of how India may have been peopled, the nature and extent of its genetic diversity, and the genetic structure among the extant populations of India.

Speaker's Profile

Analabha Basu
National Institute of Biomedical Genetics (NIBMG),
Kalyani

Analabha Basu did his Ph.D. from the Indian Statistical Institute and got his post-doctoral training from Stanford University and the University of California at San Francisco (UCSF). On his return to India, he joined the newly incepted National Institute of Biomedical Genomics (NIBMG) and is currently a Professor there. He has contributed to (i) developing novel statistical/computational methods as well as (ii) analysis of large-scale genomic data to understand the population and evolutionary history of humans. His work interrogated traditional models in statistical genetics and has resulted in the reframing of the paradigms of classical genomics and an understanding of the evolution of population groups in India. He has developed mathematical models to provide insights into a large variety of problems, including the genetic basis of sexual dimorphism and error detection in big datasets. He was one of the early implementors of machine-learning methods in genomics. His contribution to genetic epidemiology includes the identification of genes associated with metabolic disorders. However, deciphering human population-genomic structure, especially of Indian populations, using novel statistical methods is his primary academic niche. He is a Principal Investigator of the ambitious 'GenomeINDIA' project. He was elected Fellow of IASc in 2023.

Sunday, 10 November 2024
09:20–09:40 h
Session 3A

Crashing into the Unknown: The Role of Colliders in Uncovering the Secrets of the Universe

From the Higgs boson, a fundamental particle that explains how other particles acquire mass, to dark matter, an elusive force that shapes the cosmos, colliders have revolutionized our understanding of the universe. By recreating the conditions of the universe's earliest moments, scientists can glimpse the underlying forces that govern the behaviour of matter and energy. As scientists continue to push the boundaries of what is possible, colliders will likely reveal even more secrets, allowing us to better comprehend the universe and our place within it.

Speaker's Profile

Nilanjana Kumar
Shree Guru Gobind Singh Tricentenary (SGT) University,
Gurugram

Nilanjana Kumar has a Ph.D. from Northern Illinois University, Illinois, USA. She was a Postdoc at Saha Institute of Nuclear Physics, Kolkata. She was also a D.S. Kothari Postdoctoral Fellow at the University of Delhi. She is currently working at the Thanu Padmanabhan Centre for Cosmology and Science Popularization (CCSP) at SGT University, Gurugram. She has research experience in particle physics and high-energy physics. Her research interest spans the area of model building beyond Standard Model theories. She has expertise in collider phenomenology at the Large Hadron Collider and future collider experiments. She is a member of the International Linear Collider (ILC) working group and the International Muon Collider Collaboration (IMCC). Her current research interest also includes the study of dark matter, heavy neutrinos, primordial black holes and baryogenesis in the Early Universe. She was selected Associate of IASc in 2023.

Sunday, 10 November 2024
09:40–10:00 h
Session 3A

Unveiling Solid State Luminescence from Noncovalent Two-Dimensional Molecular Crystals Fabricated at Air–Water Interface

Two-dimensional (2D) molecular crystals represent an important class of materials for advanced optoelectronic applications. Owing to the monolayer or few-layered thickness, unique properties can be realized from the 2D molecular crystals which are different from their bulk organic counterparts. We introduce a promising pressure-triggered strategy to fabricate noncovalent free-standing 2D molecular crystals [1, 2]. The molecular thick, micron-long, yet stable 2D molecular crystals are formed in a controllable and efficient way on the flat-water surface having small roughness. The formation of 2D molecular crystals at different stages is monitored using *in situ* synchrotron grazing incidence X-ray diffraction measurements and atomic force microscopy. The crystal structures are probed using in situ synchrotron grazing incidence X-ray diffraction measurements and selected area electron diffraction patterns using transmission electron microscopy. The resultant 2D molecular crystals show a marked enhancement of luminescence in the solid state. The critical conformation of molecules within the 2D crystals concomitantly leads to the reduced singlet-triplet energy gap and strong spin-orbit coupling for effective mixing of the singlet and triplet states, which explains the room temperature phosphorescence origin of the luminescence and luminescence enhancement.

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Speaker's Profile

Somobrata Acharya
Indian Association for the Cultivation of Science (IACS),
Kolkata

Somobrata Acharya received his Ph.D. degree from IACS in 2003. He carried out post-doctoral research at Ben Gurion University in Israel. He is a Fellow of the International Centre for Young Scientists (ICYS) and the World Premier International (WPI) Research Centre for Materials Nanoarchitectonics (MANA) at the National Institute of Materials Science (NIMS) in Japan. He is currently Senior Professor at the School of Applied and Interdisciplinary Sciences at IACS. He is a Fellow of the National Academy of Sciences. He is a recipient of the SERB-STAR Award 2020 of the Science and Engineering Research Board, the CRSI Bronze Medal 2020 of the Chemical Research Society of India, and the MRSI Medal 2020 of the Materials Research Society of India. He was elected Fellow of IASc in 2023.

Sunday, 10 November 2024
10:00–10:20 h
Session 3A

Self-Organized Morphogenesis in Plant Regeneration: Integrating Mechanochemical and Geometric Cues

Morphogenesis is driven by intricate mechanical forces that orchestrate cellular and tissue-wide deformations. These forces, in concert with cell geometry and biochemical cues, including hormonal signals, propel the morphogenetic process. Utilizing *Arabidopsis thaliana* as a model system, we investigate morphogenesis through tissue culture-mediated shoot regeneration. Our findings reveal the pivotal role of mechanical forces in guiding the self-organization of shoot progenitors from undifferentiated callus into functional shoot meristems. We propose a "stretch–compress" model, illustrating how mechanical forces induce compression in progenitor cells and expansion in neighbouring cells. This dynamic interplay reshapes cell geometry and mechanical tensions, which are essential for the formation of the characteristic dome-shaped shoot meristem. Remarkably, this mechanistic framework is also recapitulated in organ regeneration following injury. In *Arabidopsis* root tip regeneration, we identify a similar "push–pull" mechanism, facilitating the convergence of longitudinal cell files at the regenerating tip and the re-establishment of the stem cell niche (SCN). Our study highlights the fundamental role of cell geometry and mechanochemical feedback as key regulators of tissue morphogenesis, offering new insights into the forces shaping developmental processes.

Speaker's Profile

Kalika Prasad
IISER, Pune

Kalika Prasad obtained his Ph.D. from the Indian Institute of Science, Bengaluru. He was an EMBO Postdoctoral Fellow at Utrecht University, The Netherlands, and then moved to IISER Thiruvananthapuram as group leader. His research interests are stem cells, regeneration and patterning in plants, cellular reprogramming, and developmental plasticity in plants. He was elected Fellow of IASc in 2023.

Sunday, 10 November 2024
10:50–12:00 h
Session 3B: Lectures by Fellows/Associates

Chairperson: Kulinder P Singh, IISER, Mohali

Sunday, 10 November 2024
10:50–11:10 h
Session 3B

Emergent Semiconductor Nanostructures for Photonic and Energy Harvesting Devices

The progress of emerging two-dimensional transition metal dichalcogenides (TMDs), inorganic perovskites and their heterostructures for photonic and energy harvesting devices will be presented. Hybrid heterostructures comprising zero-dimensional perovskite nanocrystals having excellent photosensitive characteristics offer the possibility to achieve next-generation optoelectronic devices with superior functionalities. This has been demonstrated through giant photo-amplification in highly stable α-$CsPbI_3$ NCs on layered WS2 mixed-dimensional heterostructures for phototransistors. Recent trends in piezotronics and tribotronics for self-powered, flexible electronic devices will be discussed.

Speaker's Profile

Samit Kumar Ray
IIT-Kharagpur

Samit K Ray is a Chair Professor in the Department of Physics at IIT-Kharagpur. He has previously served as the Director of S.N. Bose National Centre for Basic Sciences, Kolkata; Dean (Post-graduate and Research Studies), Head of the Department of Physics and Chairman of the School of Nanoscience and Technology, IIT-Kharagpur. His research interests are in the area of semiconductor materials and devices, quantum technology, low-dimensional materials and nanophotonic devices. He has served as a visiting faculty/scientist at the Tokyo Institute of Technology, Japan; University of Delaware, USA; University of Texas at Austin, USA; Queens University of Belfast, UK; and NTU, Taiwan. He is an elected Fellow of the National Academy of Sciences India, and the Indian National Academy of Engineering, and is the recipient of the INSA Young Scientist Award, UGC Homi Bhabha Award, MRSI Superconductivity and Materials Science Senior Award. He was elected Fellow of IASc in 2023.

Sunday, 10 November 2024
11:10–11:30 h
Session 3B

Elucidating the Metabolic Drivers of Fungal Morphogenesis

Fluctuations in nutrient availability are one of the most common challenges encountered by microorganisms. A common strategy employed by microorganisms to adapt to continual changes in nutrient availability is to reversibly transition to alternate cell states better suited for growth and survival in that particular environment. Fungi respond to nutrient fluctuations by undergoing reversible morphological transitions termed 'fungal morphogenesis'. This allows them to efficiently forage for nutrients, form complex biofilm communities and establish persistent infections in a variety of hosts. Current studies have largely focused on identifying gene regulatory networks that control this phenomenon. However, we lack a complete understanding of the driving metabolic processes behind such cellular decision-making events and how they are regulated. Our lab uses multiple fungal model systems, including *Saccharomyces cerevisiae* and pathogenic fungi, including *Candida albicans* and *Cryptococcus neoformans*, to address this question, as these can reversibly transition from yeast cells to filamentous cells (elongated in morphology) when nutrient levels fluctuate. Although nitrogen limitation is a driver of filamentation in these aforesaid fungi, other key metabolic drivers necessary for fungal morphogenesis have not yet been identified. We show that glucose positively influences filamentation in these fungi (in a concentration-dependent manner), and the ability of these fungi to break down glucose into specific metabolites is critical for fungal morphogenesis. Finally, using pertinent *murine* infection models, we show that a *C. albicans* strain that is compromised in metabolizing glucose efficiently is unable to establish persistent infection in a host.

Speaker's Profile

Sriram Varahan
Centre for Cellular & Molecular Biology (CCMB), Hyderabad

Sriram Varahan is currently a Senior Scientist at CSIR-CCMB. He did his B.Tech. in Biotechnology from Anna University. He then pursued his Ph.D. from the University of Kansas in the USA and moved back to India and transitioned to a DBT-Wellcome Trust India Alliance Early Career Fellow at DBT-InStem, Bengaluru, India before joining CSIR-CCMB as faculty. Currently, his lab in CCMB is using various fungal model systems to understand the fascinating phenomenon of fungal morphogenesis and its implications in fungal pathogenesis. He was selected Associate of IASc in 2023.

Sunday, 10 November 2024
11:30–11:50 h
Session 3B

On Zeros of Dedekind Zeta Functions

The Riemann zeta function holds centre-stage in number theory, and Dedekind zeta functions are its natural generalization over number fields. Conjecturally, the Riemann hypothesis is expected to hold for the zeros of the Dedekind zeta functions. However, in this talk, we will discuss certain phenomena *vis-à-vis* their zeros which are absent in the case of the classical Riemann zeta function.

Speaker's Profile

Sanoli Gun
Institute of Mathematical Sciences (IMSc), Chennai

Sanoli Gun is a number theorist. She did her Ph.D. from the Harish-Chandra Research Institute with postdoctoral stints at the University of Toronto and Queen's University before joining IMSc as a faculty member. She was elected Fellow of IASc in 2021.

Sunday, 10 November 2024
11:50–12:30 h
Session 3C: Special Lecture

Chairperson: G C Kundu, KIIT, Bhubaneswar

Epigenetics: Where Nature Meets Nurture

The longstanding nature versus nurture debate has evolved into a more integrated perspective, recognizing that genes and environment are not distinct, competing forces but work together dynamically throughout life. While our genetic makeup (nature) forms a blueprint for potential traits, the environment (nurture) plays a critical role in modifying how these genes are expressed, often through epigenetic mechanisms. The past decade has witnessed the explosion of information in biomedical sciences due to the availability of genome sequences and the development of high-throughput techniques that assay 'epigenetic' modifications. These changes emphasize how the environment continuously influences gene expression, both daily and throughout a lifetime. Thus, both genetic and environmental factors are crucial for understanding human behaviour, health, and development. I will illustrate the technological breakthroughs and trans-disciplinary approaches that have enabled a deeper understanding of disease susceptibility, especially focusing on lifestyle disorders.

Speaker's Profile

Sanjeev Galande
Shiv Nadar University, Delhi

Galande obtained his Ph.D. in biochemistry from the Indian Institute of Science in 1996. As a Postdoctoral Fellow at the Lawrence Berkeley National Laboratory, USA, from 1996–2001, he studied cancer biology. He joined the National Centre for Cell Science in Pune, India, in 2001 as a senior scientist. In 2010, he joined as a Professor at the Indian Institute of Science Education and Research (IISER Pune). In 2021, he joined as the Dean of the School of Natural Sciences at Shiv Nadar University (SNU), Delhi NCR. He also leads the Centre of Excellence in Epigenetics (CoEE) and assembled a team of scientists to study the evolution of epigenetic mechanisms using multiple model systems. The CoE in Epigenetics focusses on epigenetic modifications underlying a variety of biologically important phenomena and their role in gene expression, regeneration, cancer, behavior, aging and evolution. He is a recipient of the International Senior Research Fellowship from the Wellcome Trust, UK, from 2005–2010, the National Bioscience Award in 2006, the Swarnajayanti Fellowship in 2007, the Shanti Swarup Bhatnagar Award in 2010, the GD Birla Award for Scientific Excellence in 2015, and the JC Bose Fellowship in 2019. He is an elected Fellow of the the Indian National Science Academy, and the National Academy of Sciences (NASI). He was an honorary associate faculty at the University of Sydney, Australia and a visiting faculty at the University of Turku, Finland. He also served as the Dean, Research and Development at IISER-Pune. He was elected Fellow of IASc in 2010.

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