

Indian Academy of Sciences, Bengaluru – 34th Mid-Year Meeting

The 34th Mid-Year Meeting of the Indian Academy of Sciences, Bengaluru, was held at the New Biological Sciences Auditorium, Indian Institute of Science (IISc), Bengaluru, on 7 and 8 July 2023. The two-day event comprised of talks by the elected fellows/associates, two special lectures, a public lecture and a symposium.

The meeting commenced with a special lecture by K. Keshava Rao (IISc, Bengaluru) on defluoridation, the process of removing excess fluoride from drinking water. He highlighted the health risks of prolonged fluoride exposure, causing fluorosis. Rao discussed effective techniques like adsorption, coagulation, reverse osmosis and solar distillation, also acknowledging their limitations. He shared innovative approaches for managing rejected water from a reverse osmosis unit in Yellampalli Village, Telangana, along with insights from rainwater harvesting, emphasizing sustainable water resource management.

In the next session, Nitin Saxena (IIT, Kanpur) discussed ‘Algebra powers computation’. He highlighted algebra’s vital role in modern economies driven by algorithms. His work focuses on algebra’s integration into algorithm design, with two main thrusts: algebraic circuit properties and rapid algebraic algorithms. The lecture covered topics like zero-testing, hitting sets and algebraic dependence algorithms, as well as primality testing, root-finding and more. Saxena’s insights showcased algebra’s practical significance in shaping effective computational strategies.

Ramendra S. Dey (INST, Punjab) spoke about electrochemical synthesis of green ammonia, its prospects and challenges. With waning non-renewable energy, the global focus shifts to sustainable alternatives. Green ammonia’s role in a reliable, electrified future is vital. Traditional methods like Haber–Bosch do not align with ‘net-zero’ goals. Dey’s electrochemical approach, leveraging versatile materials, targets significant ammonia production via nitrogen reduction reaction (NRR). His team’s lab-scale NRR electrolyser with advanced catalysts promises energy-efficient ammonia synthesis.

In the next session, Somnath Bharadwaj (IIT, Kharagpur) delved into the intricate world of cosmology, shedding light on the

Redshifted HI 21-cm Line. This faint yet significant line arises from hydrogen’s hyperfine transition in its ground state and emerges as a subtle backdrop at lower frequencies. These observations unveil spatial and angular fluctuations in the background radiation, offering a window into the Universe’s evolution. Bharadwaj’s presentation encompassed predicted signals and ongoing endeavours to capture these phenomena using the Giant Metrewave Radio Telescope (GMRT). His talk bridged theory and advanced technology, reflecting humanity’s relentless quest to decipher cosmic enigmas.

Soumen Chakrabarti (IIT Bombay) shared groundbreaking insights on ‘Neural graph representation, retrieval and alignment’. He tackled complex graph matching using graph embeddings, introducing IsoNet for subgraph alignment. IsoNet’s soft assignment mechanism enables clear top responses. He also highlighted a neural gadget that approximates shared components between graphs and its integration with McsNet for effective common subgraph searches. While acknowledging the limitations of graph neural networks, he explored KGs and proposed combining complex vector graph representation with transformer-based text models for multifaceted KG tasks.

Vidya M. Prasad (IISc, Bengaluru) discussed ‘3D Snapshots into virus life cycles using cryo-electron tomography and subtomogram averaging’. Understanding virus behaviour during cellular infection is crucial in today’s pandemic context. Cryo-electron microscopy (cryo-EM) addresses the challenge of studying complex virus systems at high resolution. She highlighted applications of cryo-EM, emphasizing its potential to broaden our insights not only into virus infections but also fundamental biological processes like cell fusion and membrane protein function.

In the next talk, Narayan Pradhan (IACS, Kolkata) discussed ‘Light-emitting lead halide perovskite nanocrystals’. These innovative nanocrystals find extensive use in photovoltaic and light-emitting devices, displaying vibrant RGB colour emissions with near-perfect photoluminescence quantum yields. Despite their tiny size, these nanocrystals consistently adopt cubic shapes, sparking inquiries into their structural stability and optical properties. Pradhan explo-

red the chemistry behind their facets and shapes, accentuating the excitement of their microscopic observation.

The lectures were followed by a symposium on ‘Developing Chat-GPT for India: Challenges and opportunities in building large language models’. Partha Pratim Talukdar (IISc, Bengaluru) shed light on the significant role of Large Language Models (LLMs) in the Indian context. In an insightful address, he delved into the multifaceted dimensions of LLMs’ endeavours. Talukdar accentuated the imperative for LLMs to seamlessly integrate with the rich tapestry of languages and dialects that characterize India. Stressing the need for effective service delivery, he underscored the symbiotic relationship between LLMs and the linguistic diversity intrinsic to the nation. A focal point of his presentation was Project Vaani, a collaborative initiative jointly undertaken by IISc and Google. This visionary project sets its sights on encapsulating the diverse expanse of spoken Indian languages by meticulously cataloguing the speech patterns of millions across the country. The broader objective driving this endeavour is to engineer a technological panacea that dismantles the existing linguistic barriers entrenched in technology.

Monojit Choudhury from Turing India addressed the intricate challenges of scaling LLMs in his presentation. He highlighted deployment hurdles, such as balancing latency and accuracy, managing cost and memory on edge devices, and addressing energy and environmental impacts. He also stressed safety measures and accuracy guarantees for LLMs while cautioning against the risks of generative AI, including misaligned outputs. Moreover, he discussed the crucial intersection of LLMs with AI ethics, underlining the need for alignment with human values. He advocated for the inclusion of diverse languages and dialects to ensure accessibility and equity.

In the last talk of the session, Vasudeva Varma (IIIT, Hyderabad) discussed the potential of multilingual LLMs in creating informative encyclopaedic articles across various Indian languages. He began his discourse by delving into the complex ecosystem of Wikipedia, highlighting its fundamental framework encapsulated within the five pillars of Wikipedia. This served as

a foundation for the ensuing discussions, as Varma navigated through a strategic blueprint aimed at enriching the expanse of encyclopaedic content in Indian languages. He elucidated a dual-pronged methodology comprising a template-based approach and a generative-based approach, with the latter encompassing the multifaceted process of outline generation, short-text generation and comprehensive long-text generation. As the discourse concluded, Varma delved into the broader implications and applications of LLMs beyond mere content generation, underlining their role in a more expansive context.

The symposium was followed by a public lecture by Kavary Nambisan, a well-known surgeon and novelist. She discussed health, education and community issues in rural India, drawing from her experience serving underserved areas. She highlighted the benefits of pursuing a medical career in rural areas beyond professional growth. She presented a comprehensive picture of rural life, embracing education and diverse, imaginative ventures. Her multi-decade commitment extended beyond clinical practice to nurturing educational initiatives and catalysing innovative projects, bridging the gap between healthcare and community development. Central to her narrative was the revelation that her impact transcended medical interventions. Her involvement kindled harmony and interconnectedness within these communities, fortifying the social fabric and illustrating the profound effects of holistic engagement. Nambisan's narrative thread extended to her literary endeavours, where her medical experiences intricately wove into her stories. The synergy between medicine and storytelling yielded narratives that authentically mirrored the challenges, resilience and triumphs born from her rural medical mission.

The second day of the meeting began with J. N. Chengalur's (TIFR, Mumbai) special lecture on Gas and Galaxy Evolution. Galaxies change by converting gas into stars, an activity that peaked ten billion years ago. This evolution correlates with a decrease in the universe's average star-formation rate since then. Atomic hydrogen serves as the primary fuel for star formation, and stars emerge as the gas cools and transitions into molecular hydrogen, then collapsing due to self-gravity. Understanding the evolution of atomic hydrogen content in galaxies is essential to understanding star-

formation rates across cosmic time. However, detecting atomic hydrogen emissions, especially the 21-cm spectral line, has been challenging, limiting our knowledge of gas evolution. Chengalur presented insights from ongoing atomic hydrogen surveys of star-forming galaxies using the upgraded Giant Meterwave Radio Telescope.

In the next session, Veerendra K. Sharma (BARC, Mumbai) unveiled the physics behind antimicrobial peptides (AMPs) in combating antibiotic resistance. AMPs, promising antibiotics, target bacterial membranes to counter drug resistance. Understanding their mechanism requires studying how they interact with lipid membranes. His talk focused on how various AMPs interact with biomembranes using neutron scattering. His research revealed that AMP interactions are influenced by membrane properties. Notably, AMPs induce lipid separation within membranes, suggesting an alternative action mechanism beyond traditional pore formation. His study highlighted AMPs' selective interaction with bacterial membranes, suggesting targeted therapeutic potential.

B. S. Daya Sagar (ISI, Bengaluru) discussed the critical role of Mathematical Morphology in the fields of geosciences and geospatial data sciences. This mathematical theory has been gaining momentum in geoscience, remote sensing and geospatial data science, with the potential to revolutionize our understanding of Earth and other planets. By addressing data challenges across scales, recent developments have focused on processing sensed data, pattern retrieval and quantitative reasoning to enhance our understanding of terrestrial phenomena. In particular, the speaker explored the numerous applications of morphology in processing remote data and geoinformatics, providing tremendous value to geoscientists, remote sensing experts and spatial statisticians.

In the next session, Jayasri Das Sarma (IISER, Kolkata) discussed mouse hepatitis virus-induced neuroinflammation in an experimental animal model as a key to understanding multiple sclerosis (MS). MS involves myelin degradation, disrupting nerve communication. Sarma's research employs viral-induced demyelination models to reveal insights into mechanisms like viral persistence, latent infections, and the immune and central nervous system (CNS) interactions. Her work emphasizes studying

neural-cell-immune interplay to uncover neuroinflammation mechanisms.

Ruchi Anand (IIT Bombay) revealed insights into ribosomal methyltransferase-mediated antibiotic resistance, a critical concern due to its potential for over 300 million deaths by 2050 if not addressed. Anand's approach targets the origin of resistance, focusing on understanding how pathogens become resistant to existing drugs. These pathogens modify ribosomes, the protein synthesis machinery, through enzymes like methyltransferases (Mtases). By altering specific ribosomal bases, these Mtases prevent antibiotics from binding, leading to resistance. Anand's research, utilizing techniques like Cryo-EM and molecular dynamics, unravelled the precise mechanisms behind these enzymes. Her findings shed light on how base flipping at distinct sites within the enzymes influences the selective recognition of target RNA.

D. Pallamraju (PRL, Ahmedabad) illuminated the realm of space weather with his presentation, 'Aurora and airglow: Tracers of space weather'. Earth's historical axial dipole magnetic field, a relic of its past, sets the stage for cosmic wonders. Amidst the stars and galaxies visible to the naked eye lies the lesser-known 'airglow', a luminous spectacle often missed. Pallamraju's work deciphers airglow's brightness variations, unveiling the sun-earth physics. This, combined with insights from auroras, provides a core understanding of space weather crucial in our tech-driven lives. His innovative methods measure emissions despite daytime scatter, revealing a new understanding of daylight atmospheric dynamics.

The last speaker of the event, Soumen Basak (NII, New Delhi), revealed crucial insights into the role of cell signalling crosstalk in immunoregulation. His innovative approach combines biochemistry, mouse genetics and computational modelling to uncover the intricate interplay of pathways within mammalian cells. Notably, Basak's work highlights the impact of crosstalk between canonical and non-canonical NF- κ B pathways, extending its influence on intestinal balance and inflammation. These findings hold significant therapeutic potential for future treatments of inflammatory diseases.

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