

Indian Academy of Sciences, Bengaluru – 88th Annual Meeting

The 88th Annual Meeting of the Indian Academy of Sciences (IASc), Bengaluru, was held at SRM University, AP – Andhra Pradesh, from 4 to 6 November 2022. The three-day meeting comprised several talks, including inaugural lectures by fellows/associates, special lectures, public lectures and symposiums.

The Meeting commenced with a science-based presidential address by Umesh Waghmare (JNCASR, Bengaluru). He explained how the fundamental laws of physics could be used effectively in identifying crystal instabilities and developing predictive models that capture interactions between the instabilities and external forces to predict the material-specific functional behaviour of advanced materials. He mentioned that thermoelectrics is exciting in principle but the most challenging to study because of its conflicting requirements. The crystal instabilities of polar phonons, spin-ordering and strain, which control the functional characteristics of ferroelectrics, antiferromagnets and shape memory alloys respectively, were also highlighted. A. S. Raghavendra (University of Hyderabad) focused on the characteristics of plant mitochondria that distinguish them from animal mitochondria. He went on to explain how mitochondrial metabolism may assist plants in adapting to climatic changes such as floods, global warming and rising carbon dioxide. D. B. Ramachary (University of Hyderabad) discussed the discovery of sustainable organocatalytic reactions and their direct applications in various selective green-bond formations. Aditya Bandyopadhyay (IIT, Kharagpur) explained how interactions of electric fields at the interface of two fluids lead to interesting phenomena. He also discussed how the electric field could result in a Faraday-like instability at the air–liquid interface, bearing distinct signatures from those seen in mechanical oscillations.

The above lectures were followed by a symposium on ‘Green energy’. Ranjit Thapa (SRM University, AP), inaugurated the symposium, which addressed hydrogen generation, hydrogen fuel cells and beyond hydrogen. Ashok K. Ganguli (IIT, New Delhi) chaired the first session. He talked about photoelectrochemical (PEC) water-splitting, a promising solar-to-hydrogen conversion technique to provide a clean and

sustainable fuel (i.e. hydrogen) directly from water and solar energy. He added that the search for suitable semiconductor materials to be used as photocatalysts for efficient photoelectrochemical water-splitting applications continues.

Venkata Mohan (ICT, Hyderabad) discussed his research on the development of biological H₂ production processes employing a closed-loop biorefinery design with a multiproduct portfolio in the sustainability framework. He also explained the importance of using waste as a feedstock, working on sustainability and CO₂ as feedstock for chemical production. S. Sampath (IISc, Bengaluru) spoke about the materials developed recently for hydrogen oxidation, oxygen reduction and membranes, while charting the long history of fuel cells and their development. He traced the history of electrochemistry at IPC and IISc, and also mentioned about the historical facts on hydrogen evolution reaction. Ramendra Sundar Dey (Institute of Nano Science and Technology, Mohali) discussed his research on the role of electrolytes and counter-electrode materials in efficient ammonia synthesis considering theoretical calculations, surface characterization and electrochemical tests. He explained the classification of ammonia by colour code and also discussed the current scenario of worldwide research on nitrogen reduction reactions.

Following the symposium, the first public lecture was delivered by P. Sainath (People’s Archive of Rural India, PARI). PARI is a digital multimedia publishing in 14 languages that fills the under-reported void in media coverage of rural India. Sainath began with an inspiring story of Mallu Swarajyam, a revolutionary leader and freedom fighter from Telangana, who passed away on 19 March 2022. He mentioned that PARI documents the Legacy Archive of revolutionary leaders, and that his upcoming book *The Last Heroes* documents the lives of 15 such leaders. Sainath stated that rural India still accounts for 69% of the country’s population, even after a decade of massive migrations, and yet accounts for only 0.67% of the news on the front pages of Indian national dailies. He further discussed the current scenario of India in terms of the Global Hunger Index, World Press Freedom Index, reverse migration

and how the COVID-19 pandemic has affected rural households.

The second day of the Meeting began with a lecture by P. Vijay Kumar (IISc, Bengaluru). He explained the properties of a desired novel spreading code design for the indigenous regional navigation satellite system (NavIC) developed by Indian Space Research Organization (ISRO). An Indian patent for the design has been granted, and ISRO will incorporate the IZ4 design into the L1 SPS signal of NavIC. Anil K. Tripathi (Banaras Hindu University, Varanasi) spoke about identifying cascades of two alternative sigma factors involved in controlling rhizocompetence in a plant-growth-promoting rhizobacterium, *Azospirillum brasilense*. He highlighted how bacteria adapt to changes in their internal and external environments by expressing genes required to deal with new challenges. Tripathi also discussed in detail regarding changes in the root zone, plant rhizocompetence, the fundamental ways in which the roots respond to changes, the influence of stigma factors, etc. Giriraj Ratan Chandak (CCMB, Hyderabad) delivered a pre-recorded video presentation on early life exposure and the future risk of non-communicable diseases. He discussed the significance of this in the Indian context. He also mentioned that his major thrust had been diabetes (and its subtypes), focusing on understanding from the developmental origins of health and diseases (DOHaD) so that early intervention can attenuate the risk. Atul Goel (CSIR-Central Drug Research Institute, Lucknow) described the development of donor–acceptor-based fluorescent dyes for diagnostics and biomedical applications. He discussed ground-breaking breakthroughs in the basic building blocks for the synthesis of TAQMAn-like probes and alternative conjugation chemistry used to develop complete RT-PCR kits for identifying SARS-CoV-2 variants. He also mentioned that his team is working on efficient methods for synthesizing novel organic fluorescent dyes with absorption and emission at different wavelengths for biomedical and diagnostic applications.

The next symposium on ‘Floods in the Anthropocene’ was convened by Pradeep P. Mujumdar (IISc, Bengaluru). He addressed the ecological and topographical

aspects of the subject. He talked about recurrent patterns of floods, the changing frequency of rainfall the impact of reservoir operation on floods, etc. Rajiv Sinha (IIT, Kanpur) delivered the first lecture in this session on hydrogeomorphology and sediment dynamics of floods. He highlighted the importance of integrating geomorphic processes such as river dynamics, floodplain topography and sediment dynamics caused by natural and anthropogenic processes in flood risk assessment. Drawing examples from rivers in different geomorphic settings across India, Sinha demonstrated modern tools and techniques for process-based hydrogeomorphic modelling of floods. Subimal Ghosh (IIT, Mumbai) spoke on extreme precipitation under human-induced climate change. He mentioned that though the extreme precipitation increasing trend follows the rate of 7–8% centigrade globally, there are significant regional variations. These attribute to the varying contributions of dynamic and thermodynamic factors. The spatial variability of the Indian monsoon extremes has also increased enormously, showing the importance of local factors such as urbanization, water management, etc. Arpita Mondal (IIT, Mumbai) spoke about deciphering the role of climate change in floods. She discussed the methods and state-of-the-art for attributing flooding events to anthropogenic climate change, particularly the probabilistic event attribution framework. Three approaches that use observations and physics-based climate and hydrologic model simulations were discussed, with specific application to the 2018 flooding of Kerala that led to significant damage and loss of lives. J. Indu (IIT, Mumbai) spoke about floods from the vantage point of radars. She began her lecture by questioning the reliability of observing precipitation from satellites for examination purposes. She described the network of weather radars, rainfall forecasting utilizing radar data, radar data assimilation time limits, etc. Indu also discussed about ongoing efforts like surface water and ocean topography to utilize radar data for understanding extreme events like floods.

Following the symposium, the next lecture was delivered by Sourav Pal (IIT, Mumbai). His talk centred on distinguished varieties in the polydisc and dilation of commuting matrices. His research has helped establish a link between a distinct variety in the associated polydisc and the commuting set of n -square matrices. Binod Sreenivasan (IISc, Bengaluru) spoke about understanding the reversal of the Earth's

magnetic field. He further explained the role of slow magnetostrophic waves produced from localized balances between the Lorentz, Coriolis and buoyancy (MAC) forces in the core. While these waves support the axial dipole through the generation of helicity, their attenuation under strong forcing results in polarity reversals. Ullas K. Seetharam (TIFR, Mumbai) spoke on the topic 'You are what you eat: linking metabolism to physiology and health'. He mentioned the inability to bring about metabolic switching has been implicated in several diseases and accelerated ageing. Therefore, discovering/understanding diet/metabolism-driven mechanisms that govern physiological homeostasis is important to tackle the explosive burden of non-communicable diseases. Meena B. Mahajan (The Institute of Mathematical Sciences, Chennai) discussed why we care about formal proofs, how we can design formal proof systems and how to demonstrate their limitations. She further explained automated reasoning, verification of systems, connection to computational complexity and discovering computer-assisted proofs.

The second day of the Meeting ended with a public lecture by Ananya Vajpeyi (CSDS, New Delhi). She explored the modern history of Sanskrit, as this ancient language finds new life and significance in a world influenced by nationalism, science and identity struggle. Vajpeyi reminded us of the beauty, elegance and power of Sanskrit with references to the literature since ancient times, such as *Bhagavad Gita*, *Arthashastra*, *Dharmashastra*, etc. She explained the deep connections of Sanskrit to social inequalities relevant to modern problems related to caste hierarchy. She also raised concerns about a new difficulty added to the primordial inequality: Sanskrit being used as a weapon brandished by right-wing nationalists who want to transform the secular, multiconfessional, pluralistic Indian republic into a Hindu Rashtra.

The third and final day of the Meeting started with a discussion by Prabhat Mandal (S.N. Bose National Centre for Basic Sciences, Kolkata) on 'A new paradigm for understanding solids'. He briefly covered the conventional electronic states realized in solid-state band theory. Mandal also explored the theoretical background and experimental realization of topological electronic states in numerous condensed matter systems. Jitendra K. Bera (IIT, Kanpur) spoke on 'Water as a reactant in organometallic catalysis'. The lecture focused on the hydration of nitriles and alkynes,

olefin oxygenation, alcohol oxidation to acid and water-based oxidative deamination of primary amines. P. Sreenivas (University of Hyderabad) spoke on 'An advanced ensemble Kalman filter-based ocean-atmospheric coupled data assimilation system and its influence on improving Indian monsoon predictions.' He explained how the new system contains theoretically enhanced flow-dependency and ensemble-based analytical features. He also focused on methods vital to operational agencies adopting advanced data assimilation methods, particularly to boost monsoon predictions. Suchana Taral (Pondicherry University, Puducherry) delivered a talk titled 'Source-to-sink pathway of Himalayan sediments: new evidence from the eastern Himalayan foreland'. She suggested a novel model for the evolution of the eastern foreland basin, taking into consideration the hierarchical stratigraphic response to eustatic and tectonic stress. She also mapped out how the Himalaya has been pushed up and how the Brahmaputra river pathway has been altered. '*Mycobacterium tuberculosis* programs mesenchymal stem cells to establish dormancy and persistence', was the topic presented by Gobardhan Das (JNU, New Delhi). He explained that tuberculosis treatment displays a biphasic bacterial clearance in which majority of the bacteria clear within the first month of treatment, but residual bacteria remain nonresponsive to treatment and eventually may become resistant. He showed that *Mycobacterium tuberculosis* is taken up by the mesenchymal stem cells, where it establishes dormancy and becomes highly nonresponsive to isoniazid, a major constituent of DOTS (directly observed treatment short-course). Sneha Sagarkar (Savitribai Phule Pune University) talked about 'Reward memory recall: role of glutamatergic neurotransmission in the dentate gyrus'. She explained why the reward association process is critical for memory-guided decision-making that deteriorates mental illnesses such as binge eating disorders, drug addiction and schizophrenia.

The 88th Annual Meeting of IASc concluded with a special lecture by Sadiqali Rangwala (Raman Research Institute, Bengaluru) on 'Nobel Prize for Physics 2022: from foundational questions in quantum physics to cutting edge technology of today'. The 2022 Nobel Prize in Physics was awarded jointly to John Clauser, Anton Zeilinger and Alain Aspect for experiments with entangled photons, establishing the violation of Bell inequalities. Rangwala has worked with Aspect, and he discussed

the physics problems from the first principles and highlighted how the path-breaking experiments were conducted. He also mentioned that the foundations of quantum mechanics have been vigorously debated over the decades since its formulation. While its success is remarkable, quantum

mechanics unsettles its practitioners with its stark deviations from many structures that define classical theories of physics. Questions with respect to the nature of physical reality and definiteness have haunted even its most esteemed practitioners. The work of Aspect and his group has

cleared the way for new technology based on quantum information.

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