

Indian Academy of Sciences, Bengaluru – 87th annual meeting

The 87th annual meeting of the Indian Academy of Sciences, Bengaluru was held virtually between 12 and 14 November 2021. The three-day meeting comprised of several talks in the form of inaugural lectures by fellows/associates, special lectures, public lectures and symposiums.

Partha Majumder, NIBMG, Kalyani, delivered the inaugural talk of the Academy's 87th annual meeting. In his talk titled 'Genes as a guide to human history and culture', Majumder covered the expansive ground of human evolution and explained how the tools of genetics are helping us understand the history of our species. In the first half of his talk, he spoke in detail about the early humans and other related species like the Denisovans and the Neanderthals who inhabited the earth some five million years ago. In the latter half, he explained the origins of anatomically modern humans which appeared around 130,000 years ago. He spoke about genetic tools and methodology that enable us to understand evolutionary history. In looking at genomic data in modern humans, we see imprints of Neanderthals and the Denisovans, which according to Majumder suggests, 'We made love and not war'. In the end, he spoke about his research on understanding distinct ancestral types in India.

The inaugural talk was followed by lectures by Fellows/Associates. The first talk in this session was delivered by Neena Gupta, ISI, Kolkata. Gupta, in her 20-minute talk, spoke about her mathematical work on polynomial rings and on separable A2 and A3 forms. The next talk was delivered by Kalachand Sain, WIHG, Dehradun. He spoke about his work on using machine learning to extract reliable subsurface information from surface data. Such information, he explained, can be used for understanding earthquake processes, detecting groundwater contamination, and so on. The next speaker Ajaya K. Nayak, NISER, Bhubaneswar spoke about his work in particle theory and specifically his work about observing skyrmions, a vortex-like object that has a swirling spin configuration at room temperature. Mohit K. Jolly, IISc, Bengaluru, discussed the interface of cancer biology and computational systems modelling, applying concepts from nonlinear dynamics to understand how cancer

cells are able to metastasize to different organs. He pointed out how metastasis which causes 90% of the cancer deaths is a highly inefficient process. The speaker also explained the mechanisms of phenotypic plasticity and cell-switching in melanoma.

The post-lunch session began with R. Chandrasekar, University of Hyderabad talking about mechanophotonics, an approach developed to micro manipulate organic crystal waveguides and resonators using a confocal optical microscope attached to atomic force microscopy (AFM) cantilever tip. He further explained organic crystals, which is a new material platform for nanophotonic components and reconfigurable organic photonic integrated circuits (OPICs). Arvind Sahu, NCCS, Pune, spoke about how viruses strike back against the complement system. He elaborated about self and non-self cell discrimination, human and viral regulators, complement-inhibitory principles learnt from viral regulators, generation of a potent inhibitor, and protective role of complement during acute viral infection. A talk on algorithmic aspects of firefighting was delivered by Neeldhara Misra, IIT, Gandhinagar. In her talk, she explained how a parameterized complexity framework is used to evaluate running times of algorithms as a function of the size of input and additional structural parameters.

The symposium titled 'Some applications of probability and statistics' began with a talk on dynamics of extremes by Mustansir Barma, TIFR, Hyderabad. He discussed how extreme value statistics can help understand an approach to an ordered state. The extreme value distributions for uncorrelated variables fall into three universality classes described by the Frechet, Gumbel and Weibull distributions. However, if the variables are correlated, then new distributions emerge. The extreme value distributions are now proving to be an invaluable tool to study time-dependent approaches to a steady state, namely the process of coarsening. He broadly concluded that the behaviour within the coarsening might be governed by a pre-asymptotic regime and not the steady state. Rajesh Sundaresan, IISc, Bengaluru discussed statistical principles in the design of serosurveys which provide an unbiased estimate

of infection prevalence and help devise effective public health management strategies. In the context of COVID-19 infections, for accurate disease burden estimation, both the active infection and the seroprevalence of antibodies must be estimated. This requires use of multiple tests such as Rapid Antigen Test and RT-PCR for estimation of active infection and serology for antibody prevalence information. The speaker discussed the challenges in combining data from multiple tests and an optimal design criterion called classical c-optimal design that was used in the second survey in January–February 2021 for total burden estimation. Rahul Roy, ISI, Delhi talked about random walks and its importance for mathematics. Random walk is the simplest stochastic process that has been studied for over hundred years and has led to the very rich development of the probability theory. The speaker presented a brief history of random walks and discussed the formal mathematical structure of the model and some interesting results in this area.

The public lecture for this year's annual meeting was delivered by Thomas Pradeu a researcher–philosopher at the University of Bordeaux, France. In his talk titled, 'Why science needs philosophy', Pradeu first spoke about the divorce, or the pseudo separation, between philosophy and science in our current age, and explained how such a divorce was not the case before the 19th century. Stating the examples of Aristotle and Einstein, he furthered his point about the need for philosophy in science and explained how philosophy can help in conceptual clarification, in critically assessing scientific assumption, and in finding new connections between disparate branches of science. He also explained how such philosophy–science interdisciplinarity can be implemented in research laboratories. Lastly, by way of giving a concrete example of such confluence, he spoke about his work in immunology, and how he has been able to use the philosophical toolbox in understanding the notions of self and non-self.

The public lecture was followed by a panel discussion that attempted to address as to why data science and statistics is needed to count deaths during a pandemic. Three speakers on the panel described their

own work on counting pandemic deaths. The main speakers Arvind Subramanian, Brown University, Prabhat Jha, Centre for Global Health Research, University of Toronto, Canada and S. Rukmini, Independent Journalist, Chennai presented their work on the estimation of excess deaths during the first and second wave of the COVID-19 pandemic using repositories such as Civil Registration System (CRS), Indian sero-prevalance plus international infection fatality rate (IFR) and Consumer Pyramid Household Survey (CPHS). During subsequent discussions, Manindra Agrawal, IIT, Kanpur highlighted the need for timely reporting of data by the Governments and analysing data over extended periods. Murad Banaji, Middlesex University, UK spoke about the need to take into account contextual data in cases of undercounting of deaths. Madhuchhanda Bhattacharjee, School of Mathematics and Statistics, University of Hyderabad emphasized the need to understand the behaviour of the delay in counting deaths in a mathematical framework. Owing to excess deaths being counted in different methods with limitations of their own, the panel discussion concluded with an emphasis on using data science and statistics to derive useful information for public health policy and future projects.

The second day of the annual meeting began with a special lecture on black holes, information paradox and quantum entanglement by Spenta Wadia, ICTS-TIFR, Bengaluru. The talk reviewed a particular development in theoretical physics which brings us closer to a reconciliation of Quantum Mechanics and General Relativity within semi-classical gravity that has been enabled by a new gravity formula for the entanglement entropy.

The special lecture was followed by lectures by fellows/associates. Dipshikha Chakravorty, IISc, Bengaluru, spoke about an ancient pathogen called salmonella and its life in a vacuole. She further explained about the evasion strategies of salmonella and the functioning of bactericidal permeability-increasing protein (BPI) in vacuoles. The speaker also indicated that her research team is currently working on ways to stop brain infection/meningitis caused by salmonella. Vamsi Pingali, IISc, Bengaluru, discussed two partial differential equations (PDE) arising from differential geometry and physics. In his research, it was proved that solutions exist in two such PDEs if and only if certain algebro-geometric conditions are met. The speaker

also suggested that similar results can eventually help not only with physics but also with algebraic geometry.

The next session, a symposium on electrochemical energy storage and sustainability, began with a talk on green hydrogen for India's green future. The speaker Ashish Lele, CSIR-NCL, Pune, presented some key findings of the sixth IPCC Assessment Report of climate change and emphasized the role of low carbon hydrogen in achieving the targets set by the India's Panchamrut action plan for climate action. He presented some opportunities for hydrogen in India that can enable the country to go from fossil energy importer to clean energy exporter. The talk by S. A. Ilangoan, VSSC, Thiruvananthapuram focused on the supercarbatteries, an innovation in the area of electrochemical energy storage system that efficiently facilitates high rate discharge while retaining the higher energy density. The features of higher cell voltage, higher power and energy density and ability to fast discharge make it a promising energy storage device suitable for powering electric vehicles with significant performance advantages thus overcoming present issues associated with the conventional hybrid systems of externally connected battery and supercapacitor. Amartya Mukhopadhyay, IIT, Mumbai dealt with the stress-induced degradation of electrode materials in alkali metal-ion batteries. He began some of the degradation mechanisms of the materials and electrolytes that raise the impedance. The main focus of the talk was the electrode stress induced degradation that causes loss in electrode active materials, loss in connectivity, causes rise in impedance and accrues the SEI (solid electrolyte interphase)-related problem. N. Kalaiselvi, CSIR-CECRI, Karaikudi, covered various aspects of lithium and beyond lithium technologies for storage and e-mobility applications. The consumer market based portable electronics and e-gadgets use lithium-ion and sodium-ion batteries while electric vehicles and hybrid electric vehicles for e-mobility use lithium-ion/lead-acetate batteries and supercapacitors. The speaker discussed the work being carried out at CECRI in the lithium-ion and sodium-ion technology areas.

The symposium was followed by lectures by fellows/associates. The first talk in this session was delivered by Sanjeev Khosla, CDFD, Hyderabad. He spoke about his work on the DNMT3L protein and its role in contributing to non-mendelian inheritance. He presented his team's

work on using cell lines and drosophila crosses to understand the mechanism of histone modification through DNMT3L. In the second talk, Sadiqali Rangwala, RRI, Bengaluru, spoke about his work on understanding the interactions between ions and atoms at the quantum levels and described his team's work which upended the Major and Dehmelt theory of cooling, an established dogma in the field. The third speaker Shreya Karmakar, Jadavpur University, Kolkata spoke about the origins of corundum, or ruby, in the Sittampundi layered complex in south India. In explaining her work, she offered a new petrological model for the origin of ruby in the natural world. The last talk in the session was delivered by Anirban Basu, NBRC, Manesar. He started by explaining how existing drugs can be repurposed to be used against other illnesses. He presented his work on repurposing minocycline to be used against the Japanese encephalitis virus and presented data from the clinical trials.

The second day ended with a public lecture by Arunabha Ghosh, CEEW, New Delhi on the topic 'From energy transition to energy revolution: India's journey to energy security'. He began his talk highlighting that the choices we make on our energy future will determine our development prospects, how we educate ourselves, how we build our public health infrastructure, what kind of industries we build, the economic sectors we promote and even the kind of governance that we have, not just for running the energy sector, but in fact running our lives. Ghosh indicated that until we change our energy systems we will not be able to create an economy that is resilient against the growing climate risk vulnerabilities. For this, India must go through four major transitions: shift from traditional to modern energy, shift of population from rural to urban areas, deeper integration into global energy markets, and shift from growth to sustainable growth.

The final day of the annual meeting began with a lecture by Vivek Agarwal, IIT Bombay, on his contributions to research on solar photovoltaic (PV) technology. The speaker highlighted that currently solar PV has an edge over other renewable resources as it has low-maintenance cost, more lifetime and is noise-free. Some of the major areas of focus of his study are Maximum Power Point Tracking (MPPT), Partial Shading and Grid Connected Systems. Ritu Gupta, IIT, Jodhpur spoke about fluorinated nanomaterials for energy and healthcare applications. She explained

further about the fluorination mechanism of ferric oxide (Fe₂O₃) and stannic oxide (SnO₂). The speaker has also successfully tested a humidity sensor for breath-rate monitoring and touch sensing during her research. The next talk by Anjan K. Banerjee, IISER, Pune, discussed the induction of aerial and belowground tubers in potato as a classic example of developmental plasticity and modulation of plant architecture. The take home message of the lecture was that in potato, all axillary meristems have the capacity to form tubers and under

permissive conditions any shoot meristem can produce aerial tubers. However, this potential is suppressed, except in stolons.

The annual meeting came to a close with a special lecture by Ashok Sahni, Panjab University, Chandigarh, on greenhouse explosion of biodiversity, focusing mainly on Indian Eocene Palaeobiota. He indicated that the global diversity has increased exponentially during the Eocene greenhouse and the Eocene thermal events have triggered biotic radiations and species diversification. He further elaborated the importance

of amber, a fossilized tree resin and how its inclusions such as fungi, mosses, bees, wasps, termites help to characterize micro-environments. He also explained as to why the development of mycorrhizal associations is considered a key innovation that has enabled vascular plants to extensively colonize terrestrial habitats.

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COMMENTARY

Innovation barriers and a possibility kaleidoscope: the NEP imperative

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In the context of research and innovation objectives of National Education Policy (NEP), this note elicits five innovation barriers prevailing in the higher education institutions in India and presents an innovation possibility matrix based on two dimensions of resources (lightweight versus resource-intensive) and openness (open versus closed). At the policy level, this approach helps as a lens for informed resource allocation that is balanced across different institutions and kinds of innovations. At the institution level, it helps us understand what kind of innovation direction can institutions take in different projects, the gaps to be filled and capabilities to be built.

One of the core features of the National Education Policy (NEP) is its focus on research and innovation. While autonomy, good governance and new institutional structures are pathways to realize this, how the idea of innovation is conceived and enacted in a densely diverse educational system is a significant implementation challenge.

In the background of research and innovation objectives of NEP, this note elicits five prominent innovation barriers prevailing in the higher education institutions (HEIs) in India and presents an innovation possibility matrix based on resources and openness.

The research, development and innovation plan of NEP is evident in three ways. First is the establishment of new institutional structures. The National Research Foundation (NRF) is one such initiative to build high-quality research institutions with collaboration of Government, universities and industry. The National Education Technology Forum (NETF), another proposed institutional structure, focuses on educational technology across a range of

institutions, and aims to improve pedagogy and assessment resulting in innovations in teaching and learning processes.

Second is the thrust of NEP on priority and disruptive research areas such as green technologies, Artificial Intelligence (AI), Virtual Reality (VR), robotics, nanotechnology, block chain and Internet of Things. Third are the pedagogical measures. Modular examinations to test core capacities, degrees by research work, streamlining higher research degrees, more incubation facilities, technology development centres, deeper industry–academic interface and interdisciplinary research are some pedagogical and general educational measures that can support the research ecosystem.

It is expected that as a combined outcome of all these factors, the level of innovation and the number of intellectual property attempts will improve in our institutions. However, this enhancement will be uneven unless we are mindful of two important factors, viz. what prevents institutions from innovating and what possible spectrum of innovations exists and is available for institutions.

Innovation barriers

The successful implementation of innovation initiatives envisaged in NEP needs to recognize the current barriers to innovations in our institutions. Clarifying and plugging these gaps can ease the implementation process. From experience and the literature, we distill five innovation barriers here.

Lack of space for failure and experimentation

By default, education honours achievers and is therefore prone to discard failures. This is also visible in the approach of academia in confronting uncertainty. Resulting from the academic tendency to overrate failures and avoid uncertainty, HEIs provide negligible space for experimentation, which reduces the possibility for innovations.

At one level, innovation is viewed as the number of attempts irrespective of the results. Larger quantity of ideas is not sufficient for innovation. Yet, every great idea