MEETING REPORT

Indian Academy of Sciences, Bengaluru – 32nd Mid-Year Meeting

The 32nd mid-year meeting of the Indian Academy of Sciences was held virtually between 4 June and 2 July 2021. The meeting comprised of five sessions organized around different subject themes. First four sessions were held on every Friday of the month of June and the final session was held on 2 July.

Day 1: Mathematics, earth and planetary sciences and physics

The first talk was delivered by G. D. Veerappa Gowda (TIFR Centre for Applicable Mathematics, Bengaluru). He began by discussing the single conservation law with a flux function discontinuous in the space variable that finds application in several models of physics and engineering. He discussed the development of generalized entropy solutions for such equations and presented applications related to oil reservoir simulations.

Agnid Banerjee (TIFR Centre for Applicable Mathematics, Bengaluru), in his talk, discussed applications of unique continuation, recent results on strong unique continuation and backward uniqueness results for sublinear parabolic equations.

The next talk by Prosenjit Roy (IIT Kanpur) discussed the properties of solutions of partial differential equations set on cylinders. The speaker talked about the asymptotic analysis for problems in cylindrical domains tending to infinity and also discussed future problems in the area.

Dipankar Banerjee (ARIES, Nainital) described the impact of the variability of the sun in small timescales of the order of seconds, minutes and hours and longer timescales such as years. He discussed how multi-wavelength observations of the sun are being used to understand the different layers of the sun. He also drew the attention of the audience to the Aditya L1 mission, a space mission to study the sun. The talk concluded with the speaker highlighting certain long-term studies being done on sun spots.

The talk by Virendra M. Tiwari (CSRI-NGRI, Hyderabad) was on isostacy and strength of the continental lithosphere in the context of studies done on the Indian plate. The studies concluded that effective elastic thickness (EET) estimates of ocean lithosphere clearly define the mechanical lithosphere and are consistent with physical models. However, the EET estimates in the continent are perplexing due to multi-layered rheology, presence of water, etc., with some old cratonic regions showing higher values than continental rifts and phanerozoic mountain belts. Thus both models of continental lithospheric strength compete with each other depending upon the underlying lithospheric properties.

In his talk, Jaydeep K. Basu (IISc, Bengaluru) discussed quantum emitter assemblies coupled to plasmonic arrays that result in long range polaritonic energy transfer and photon spin-momentum locking. The talk highlighted that coupling of quantum emitters to de-localized hybrid plasmon-photonic cavity modes leads to very long range polaritonic transport. Achiral quantum emitters coupled to high wave vector evanescent modes of plasmonic hyperbolic metamaterial leads to the emergence of photon spin-momentum locking.

Day 2: Plant sciences, medicine and general biology

The first talk of the session, delivered by Ashverya Laxmi (NIPGR, New Delhi) was about how FCS-like zinc finger (FLZ) proteins fine-tune nutrient signalling and growth, and stress-response trade-offs in plants. The take home message of the session was that FLZ8 might provide a feedback mechanism to keep TOR activity under check so as to accumulate basal levels of SNF1-related protein kinase 1 (SnRK1); which might be essential for organism survival under sudden stress conditions.

Amit Jaiswal (IIT Mandi) discussed plasmonic nanocapsules and its application in photothermal therapy. The talk concluded with the speaker highlighting that plasmonic nanocapsules, which has absorbance in the NIR region, can suitably be used for photothermal application. It has a porous structure that can be used for loading drug molecules, and its intrinsic electromagnetic hot-spots can be used for surface-enhanced Raman spectroscopy (SERS) sensing and SERS bio-imaging.

The next talk by Rishikesh Narayan (IISc, Bengaluru) discussed heterogeneities in neural circuits, their origin and their implications. He highlighted that neural circuits are not made of repeating homogenous computational units, several forms of neural circuit heterogeneities are present, and heterogeneities reflect the expression of degeneracy in emergent function. The talk concluded with the speaker emphasizing that experimental analyses and computational models should account for all neural circuit heterogeneities, as they critically affect functional outcomes.

Arun K. Shukla (IIT Kanpur) discussed the structure, function and modulation of G protein-coupled receptors (GPCRs). He highlighted that there is a great deal of structural and functional diversity in GPCR beta-arrestin complexes that drive their distinct functional outcomes and regulatory paradigms.

The final session by Dinesh Kumar (CBMR, Lucknow) was on highly sensitive and specific panel of diagnostic biomarkers for differentiating sarcoidosis from tuberculosis identified by using NMR-based serum metabolomics approach.

Day 3: Chemistry and engineering

The first talk by Rahul Banerjee (IISER, Kolkata) on porous framework materials began with metal organic frameworks (MOFs) that are used to store hydrogen. He also discussed stability problems in MOFs. The latter part of the discussion involved covalent organic frameworks (COFs) that find applications in gas storage, photo-conducting material, membrane separation and drug delivery. He discussed the challenge and complexity in COF synthesis and also talked about a novel methodology by which COFs can be synthesized to display higher porosity and crystallinity over their reported powder form.

Satish A. Patil (IISc, Bengaluru) gave a talk on coherent processes and emerging trends in molecular semiconductors. He discussed the advantages of molecular semiconductors over silicon that includes engineering functionality, solution processability and flexibility. He also discussed what limits the mobility in

conjugated polymers and the molecular design for the synthesis of high mobility polymers.

Uttam Manna (IIT, Guwahati) talked about the design of durable and functional bio-inspired interfaces. He began as to how the concept of wettability evolved over time and also gave an overview of the research activities at IIT Guwahati in this area. He then talked about the design of superhydrophobic interfaces and related challenges such as physical durability challenges and discussed in detail approaches to combat the durability and scalability challenges.

The talk by Debatosh Guha (University of Calcutta, Kolkata) described his work in the area of antenna research that led him and his group to move from engineering to science and vice versa. He talked about an integrated antenna in L-band that he designed for a Canadian Government Laboratory. He also described the challenges in developing printed and dielectric resonator antennas operating over a wide range of frequencies and to be deployed on various working platforms.

Manik Varma (Microsoft Research India, Bengaluru) talked about a new research area in machine learning called extreme classification dealing with multi-class and multi-label problems involving an extremely large number of categories. Extreme classification finds applications in information retrieval, natural language processing, computer vision and bioinformatics and has come to be a thriving area of research in academia and industry.

Manan Suri (IIT Delhi) in his talk highlighted the significant role played by non-volatile memory (NVM) in several novel applications. He highlighted the research being carried out at IIT Delhi in the area of memory applications that include conventional applications related to pure storage and unconventional applications such as (1) hybrid CMOS-NVM circuits such as content addressable memory, non-volatile SRAM and use cases on security and (2) intelligence or compute-centric applications such as neuromorphic systems, machine learning realizations and in-memory computing.

Day 4: Earth and planetary sciences and physics

The first talk delivered by T Narayana Rao (NARL, Tirupati) was on dominant rain microphysical processes in monsoon clouds. He highlighted some areas such as the seasonal differences in drop size distribution (DSD), seasonal variation in bright band thickness, isotopic analysis of rainwater, and space-borne precipitation radar.

Shakil Ahmad Romshoo (University of Kashmir, Srinagar) discussed the implications of shrinking cryosphere under changing climatic conditions. In his talk, he covered areas such as the changes and observations of glacier mass balance, glacial thickness observation, and impacts on water availability.

The next talk by M. K. Verma (IIT Kanpur) discussed the origin of time asymmetry and friction in multiscale systems. He emphasized time reversal symmetry by friction, forcing, non-linearity and asymmetric energy transfer. The speaker concluded by saying that multiscale description helps understand breaking of time reversal and mirror symmetries.

Vikram Vishal (IIT Bombay) discussed whether carbon capture and storage (CCS) in India could accelerate the efforts towards net-zero emissions. The speaker came to the conclusion that there is significant potential for storage of captured carbon dioxide in sinks in India. A new scope for energy security while addressing climate change mitigation, and advancing technology can lead to implementation of variety of CCS projects.

Binita Pathak (Dibrugarh University, Dibrugarh) described the chemistry–climate interaction over the Eastern Himalayan foothills region. She also drew attention of the audience to the decreasing rainfall pattern and tea production in Assam.

The last session by S. Suresh Babu (VSSC, Thiruvananthapuram) was on Aerosol Radiative Forcing over India and regional climate. He emphasized the long-term trend in aerosol optical depth, springtime enhancement in elevated aerosols, spatial distribution of dust optical depth, and single particle soot photometer.

Day 5: Symposium and public lecture

The final day of the meeting began with a symposium titled 'Pollinators and seed dispersers: Nature's gardeners' held on the occasion of FAO's International Year of fruit and vegetables.

The first session in the symposium was delivered by Priya Davidar (Pondicherry University). In her talk, she spoke about her work on wild brinjal, *Solanum insanum* L. She presented her research on how the crop variety of brinjal is much more susceptible to pest attacks than the wild variety and further explained the importance of preserving wild varieties. She concluded that the transgene from the crop variety will likely admix with the wild population. 'It's an experiment that is waiting to happen,' she said.

The second talk was delivered by Dharam Pal Abrol (Sher-e-Kashmir University of Agricultural Sciences & Technology, Jammu). In his talk, he spoke about the different pollinators that pollinate fruit crops and explained their crucial role. He further detailed conservation efforts that can be undertaken to save the declining population of pollinators.

The next speaker, Rajesh Tandon (University of Delhi, Delhi) spoke about his work on the reproductive biology of the Himalayan seabuckthorn, commonly known as Leh berry. He spoke about his research on cross-pollination in this plant, which mainly occurs through wind pollination. He further talked about the genetic diversity between the male and female genomes of the plant, and their recent separation into two different sexes.

The last speaker, Aparajita Datta (Nature Conservation Foundation, Bengaluru) spoke about the role of hornbills as seed dispersers. Speaking about her research of over 20 years on hornbills, she explained different aspects of the bird's ability to disperse viable seeds long and wide. Hornbills, she said, can be considered the 'farmers of the forest'.

Following the symposium, a public lecture was delivered by Abhijeet Banerjee, a Nobel laureate from MIT. His talk titled 'Getting out of a poverty trap' detailed the conditions that make it difficult to cross the poverty threshold, hence the trap. In the later part of his talk, he presented evidence from his work in West Bengal and Ghana and pointed to changes in social change policies that can have durable effects in helping the poor.

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