MEETING REPORT

Indian Academy of Sciences, Bengaluru – 29th Mid-Year Meeting*

The 29th Mid-Year Meeting of the Indian Academy of Sciences, Bengaluru was held on 29–30 June 2018 at the Infosys Campus, Mysuru. The two-day event included a public lecture, 2 special lectures, 18 lectures by Fellows/Associates and 2 symposia.

The first special lecture on research, relevance and public good was delivered by G. Nageswara Rao (L V Prasad Eye Institute, Hyderabad) using health care as an example. Health care is dependent on the economic condition of the country significantly. Universal health coverage in India needs to provide quality comprehensive care to the 56% of the population that falls below the empowerment line. To provide an example of a robust health care system built on the basis of evidence, Rao cited the case of blindness.

According to a WHO report, more than half the world's population is seeking services for eye care. To add, India shares a disproportionate share of the burden of global blindness. Rao cited an ambitious epidemiological study called Andhra Pradesh Eye Disease study that was conducted to understand the magnitude of the problem, and the major causes that contribute to blindness and vision impairment in the country. The study uncovered that uncorrected refractive error and cataract are the two major problems that contribute to blindness.

With the information that this epidemiologic study provided, a five-tier model for universal eye care was developed that provides comprehensive eye care, commitment to quality, continuity of care, is closer to the doorstep of the people and involves community participation. Rao elucidated the initiatives undertaken under the various tiers of the model. The focus on research is at the tertiary care level of the model. The institute has a fairly large research group with clinicians putting in dedicated research time, depending on their level of interest. The institute has been able to create a culture of research by developing a quality team, and has collaborations with leading Indian and international institutions. He suggested that a combination of several areas like, epidemiology, clinical research, basic laboratory research, patient reported outcome research, health systems research, together with appropriate leverage of technology can be used to develop a model/system of health care delivery, which can be replicated in other areas of medicine to provide appropriate health care.

The special lecture was followed by a series of lectures by Fellows/Associates of the Academy. An important problem in analytic number theory is to understand the values of zeta and L-functions on the critical line. There is a general bound for these values that follows from the Phragmén–Lindelöf principle. Improving this convexity bound is known as the subconvexity problem. Ritabrata Munshi (ISI, Kolkata) in his talk, described the salient features of this important problem.

Large proportion of natural products, pharmaceuticals and agrochemicals contain heterocycles. Transition metal catalysed approach has brought new direction to the synthesis of N-heterocycles with increased functional group tolerance, higher chemical yield and excellent selectivity with high step economy. In his talk, Pazhamalai Anbarasan (IIT Madras) described his recent efforts in synthesis and transition metal-catalysed functionalization of α-diazocarbonyl compounds and its nitrogen analogue.

The health burden of kala-azar is most shared by the Indian subcontinent and East Africa. The limited availability and affordability of existing antileishmanial drugs and rising incidents of HIV-coinfection and drug resistance, call for novel drugs and vaccines against this debilitating and potentially fatal infection. Highlighting these and other challenges which need to be overcome to realize the dream of eradication of kala-azar by 2020, Anuradha Dube (CDRI, Lucknow) discussed the need of developing a two-pronged strategy – killing the parasite while boosting host immunity – to win the battle against kala-azar. The speaker also discussed the development of chimeric and recombinant vaccines against kala-azar and the role that plant-based compounds can play in the development of novel drugs.

The ease of application and the ability to decipher the interconnection between various molecular states and properties makes Raman spectroscopy one of the most powerful tools available for understanding the microscopic origin of molecular properties. Citing various examples from his studies including 1T-TiTe2 – a topological insulator – and zeolitic imidazolate framework ZIF-8, C. Narayana (JNCASR, Bengaluru) highlighted the potentials and possibilities of Raman spectroscopy. He also highlighted the use of surface enhanced Raman spectroscopy in understanding the selective inhibition of oncogenic Aurora A Kinase by Felodipine.

Ramesh Hariharan (Strand Life Sciences, Bengaluru) shared his experiences of working with novel genomics technologies to provide effective diagnoses for genetic disorders. He discussed the various challenges faced in terms of speed, efficiency and cost of techniques and the promises that genomic technologies like Next Gen Sequencing (NGS) hold in the areas of neonatal diagnosis and gene editing.

Moving to the applications of technologies in geology, V. K. Gahalaut (Ministry of Earth Sciences, New Delhi) presented his work on the GPS measurement studies performed by his team along the Indo-Burmese arc which provides important insights into the seismic activity in this region. He highlighted the applications of techniques such as geological mapping, subsurface imaging and GPS measurements in providing valuable information towards quantification of plate tectonics.

One of the most influential figures of our century – Francis Crick – is best known as the co-discoverer of the double helix of DNA in 1953. As the name suggests, the symposium on 'Remembering Francis Crick: A multifaceted visionary scientist' highlighted the scientific contributions of Francis Crick and brought together molecular biologists across various institutions on a single platform to discuss the recent developments in the field.

With the advent of nanotechnology, DNA has emerged as the basis for

making complex nano-architectures and devices. In her talk, Yamuna Krishnan (University of Chicago, USA) discussed the development of synthetic, chemically responsive, DNA-based fluorescent probes and the use of these probes as a DNA-based pH sensor in worms to yield information about organelle activity in living cells. The group has expanded this technology from ion imaging to quantitatively imaging reactive species as well as enzymatic cleavage with subcellular spatial resolution *in vivo*.

Francis Crick is known not only for the discovery of double helical structure of DNA, but also for proposing the 'adaptor hypothesis' which filled an important gap in the information flow from DNA to proteins through tRNA. Rajan Sankaranarayanan (CCMB, Hyderabad) traced the evolution of our knowledge of tRNA as a mere adaptor molecule to its role in multifarious cellular functions including sperm maturation and fertilization, maintaining translational fidelity, and presented two aspects of his recent work on tRNA gene expansion in higher eukaryotes and evolutionary selection pressures.

Souvik Maiti (IGIB, Delhi), emphasizing the significance of RNA G-quadruplexes translational regulation discussed the possibilities of unusual combinations of guanine residues involved in RNA G-quadruplex formation in the 5′ untranslated regions of different genes.

Concluding the symposium, Manju Bansal (IISc, Bengaluru) shed light on the life and work of Francis Crick. The talk presented a bird's eye view of some of the scientific ideas proposed by Crick and discussed the recent developments in these areas. The talk also highlighted why Crick is truly a 'renaissance scientist'.

The intangible relationship between politics and violence has been a long and ongoing debate. The contradictory ideas for the need for the ruler to exercise force while discharging his duties and non-violence have resulted in an enduring and irresoluble tension in the ancient Indian political thought. The speaker, Upinder Singh (University of Delhi) in her public lecture, explored the various thoughts on political violence in general and war, punishment, and the interface with the forest in particular. Establishing that there is no single 'Indian' theory of kingship or political violence, the speaker highlighted that while ancient texts justified and aestheticized political violence, and prescribed the use of force to maintain social order and ensure the well-being of subjects, they also prescribed strict code of conduct and discipline while exercising such force. The talk sought to distinguish necessary force from unnecessary, disproportionate, excessive and random force.

The second day of the meeting saw another series of lectures by Fellows/Associates of the Academy followed by a symposium and a special lecture. Fluorescent chemosensors have been explored in diverse fields such as biology, physiology, pharmacology and environmental sciences. Manoj Kumar (Guru Nanak Dev University, Amritsar) provided an overview of the principle of fluorescent sensing and application of fluorescent probes in detection of metal ions, explosives, reactive oxygen species, diseases, cellular pH, reactive sulphur species and anions.

Applications such as fast flow and desalination devices, voltage generation, flow sensing and nanofluidics require an understanding of the properties of strongly confined water. Prabal K. Maiti (IISc, Bengaluru) demonstrated that strong confinement of water in structures such as carbon nanotubes modifies the structural, thermodynamic and dynamic properties of water.

Nagasuma Chandra (IISc, Bengaluru) discussed a study that resulted in the identification of a host biomarker signature comprising 10 genes that can discriminate between TB and healthy controls as well as distinguish TB from latent tuberculosis and HIV in most cases.

The polyphenol compounds in green tea are associated with many functions including antioxidant activities and have generated great interest in green tea. Giving these claims a scientific basis, Swagata Dasgupta (IIT Kharagpur) explored the interactions of polyphenols with human proteins. Her studies indicate that polyphenols in green tea inhibit angiogenesis. The compounds are found to be non-competitive inhibitors of human protein – Ribonuclease A and to protect human γB-crystallin from UV radiation-induced damage and aggregation, opening up new avenues in healthcare and drug discovery.

The historic discoveries of gravitational waves and neutron star mergers have opened up a new window to the universe to unravel some of its greatest mysteries. The discovery has also given a major boost to the Indian research community who has been part of these global experiments. The talk by Varun Bhalerao (IIT Bombay) focused on the discovery and understanding of the binary neutron star merger, and what it means in the days to come.

The symbiotic relationship between nitrogen-fixing bacteria and specific species of angiosperms provides a crucial lead on engineering in crop plants to reduce their dependence on nitrogenous fertilizers. Exploring the possibility of engineering this symbiosis in crop plants outside monophyletic clade, Maitrayee DasGupta (University of Calcutta) discussed the common symbiotic pathways, transformation techniques that can be used, and the prime factors responsible for the adaptations to symbiotic nitrogen fixation in the backdrop of the challenges to its extension to plants outside the competent clade.

Integrated circuit (IC) chips are inevitable in electronic products used today and the semiconductor industry constantly strives towards developing ICs with increased performance. However, one of the major challenges faced by the industries is with respect to 'transistor ageing' and ensuring reliability of ICs. Souvik Mahapatra (IIT Bombay) discussed the methodologies and models for predetermining the ageing and failure of ICs. The speaker proposed methods which could aid in accessing and rectifying potential reliability issues during CMOS (complementary metal-oxide-semiconductor) technology qualification.

Recent incidents of occurrence of hydrologic extremes, i.e. floods, droughts and heat waves, and their impacts on Indian society and economy drive home the need for furthering our fundamental understanding of meteorological processes. In this context, C. T. Dhanya (IIT Delhi) elaborated on the importance of statistical learning and theoretical modelling in the development of holistic models to simulate regional hydrological cycle behaviours.

A symposium on blockchain and cryptocurrency covered the theory and technology behind the topic. Madhavan Mukund (CMI, Chennai) provided an introduction to blockchains. A blockchain is used to implement a distributed ledger. The real challenge to such a collectively maintained ledger is integrity and consensus, which are ensured through cryptography and distributed consensus

protocols respectively. Blockchains use the proof of work concept to add new blocks, which in turn fetch an incentive to people who add blocks.

In blockchains cryptographic primitives such as hash functions and public key cryptography are required to achieve anonymity, authenticity and secrecy. These concepts were explained by Bimal Roy (ISI, Kolkata). Hash functions ensure the properties of one-wayness, second pre-image resistance and collision resistance. Public key cryptography achieves the function of authentication.

The economic aspects of bitcoin were explained by S. P. Suresh (CMI, Chennai). Bitcoin is an infinitely divisible digital currency that can be used to trade for goods/services or can be exchanged for other forms of currency. The bitcoin algorithm based on block chain technology that runs on all nodes in a peer to peer network, generates bitcoins. According to the monetary policy of the algorithm, 21 million bitcoins will all be minted by 2148 after which the minting stops. Since there is no central authority to decide on factors such as money supply, etc., any changes in the system are carried out democratically. It is truly international since anybody with internet access can transact in bitcoins without having to submit to the laws of the particular region. He also explained the technical aspects of bitcoin generation and incentive structures in bitcoin.

Rajeeva L. Karandikar (CMI, Chennai) concluded the symposium by providing the use of blockchains beyond cryptocurrency. The basic premise is that distributed copies are difficult to tamper with. Blockchain technology can be used in applications such as logistics/shipping, land and property records, etc. However these applications have several unanswered questions such as acceptability to the people owing to lack of a central authority and incentive structures in areas such as land records.

The event concluded with a second special lecture by Raman Sukumar (IISc, Bengaluru), who provided a perspective of long-term thinking in ecology that was substantiated by insights from long-term monitoring of a tropical forest in Mudumalai. This research is especially relevant in the context of global climate change.

The Western Ghats show enormous variation in rainfall across the gradient. Correspondingly there is a change in the type of vegetation from dry thorny forest to dry deciduous forest to moist deciduous forest to patches of evergreen forests as we move west. Sukumar and his team set up a 50-ha permanent plot in the dry-deciduous forest of Mudumalai in 1988. Since this represented only one point in the rainfall gradient, 19, one-hectare plots were also set up along the rainfall gradient. The fate of over 80,000 individuals from nearly 200 species was monitored by the team over three decades. The long-term monitoring of the forest provided crucial information on population trends, mortality and recruitment, growth, survival and diversity of species owing to factors such as fire, rainfall, etc.

Sukumar indicated that the monitoring has also provided new insights into the theoretical aspects. The autecological/individualistic theory was favoured by the work carried out in Mudumalai. Also, looking at different forests around the world, data supported the fact that environmental stochasticity overrides both niche and neutral considerations in driving the dynamics of the forest.

Geetha Sugumaran*, Indian Academy of Sciences, Bengaluru 560 080, India; **S. Priya*,** Current Science Association, Bengaluru 560 080, India.
*e-mail: geethas@ias.ac.in; priya@ias.ac.in

MEETING REPORT

Techno-foresight in R&D*

In this era of rapid technological developments, new approaches are necessary to stay relevant and competitive; the global industry is becoming more and more science and technology (S&T)-centric. The future industry is expected to be driven by S&T-enabled products and innovations. However, S&T products need large investments and long development timescales. Techno-foresight is the process of anticipating the broad contours of technologies to come. It can also help in overall policy planning; unlike techno-foresight for a specific product, techno-foresight in policy can be used to ensure inclusive economic growth through development of the complete industrial ecosystem. It is an emerging area, enabled by the recent advances in data analytics, modelling and simulation.

Techno-foresight is going to play increasingly important roles in industrial and R&D investment planning. The methodologies as well as applications are going to evolve and expand. There is need for an institutional effort for the development and upgradation of methodologies, applications and capacity-building. Also, carefully developed techno-foresight practices can be vital for agencies like the Council of Scientific and Industrial Research (CSIR) engaged in S&T-driven industrial research.

Techno-foresight encompasses a broad range of goals and a wide spectrum of methodologies. Technology Visions are regularly generated by agencies like DST aimed at broad national agenda. However, there is need for focused and systematic applications of techno-foresight in R&D aimed at industrial products. The First National Workshop on Techno-Foresight and R&D Investment Planning was aimed to create an effective techno-foresight platform by integrating modern techniques and emerging demands, covering recent advances and future directions in data analytics, projection and simulation methodologies to make techno-foresight an applicable tool for the industry. The participants included experts as well as thought leaders; the event was structured in terms of sessions to cover both basic issues, techniques and applications of techno-foresight in S&T-driven R&D.

Internationally, techno-foresight is fast emerging as an important science. Many

*A report on the first National Workshop on Techno-Foresight in R&D and Industrial Investment Planning held at CSIR-NISTADS, New Delhi on 11 October 2017.