MEETING REPORT

Seventeenth mid-year meeting of the Indian Academy of Sciences*

The seventeenth mid-year meeting of the Indian Academy of Sciences was held in Bangalore recently, in which over 200 scientists participated. The programme was structured to consist of three technical sessions, wherein Fellows and Associates of the Academy presented their current work. A characteristic feature of the technical sessions was the emphasis on collaboration within and between sciences. In addition, there were two special lectures and one public lecture. A side event of the meeting that invoked considerable interest and appreciation was the exhibition by Sukant Saran, Tata Institute of Fundamental Research, Mumbai tilted 'Scientific art – a creative interaction'. The works, which were largely collages or morphed forms of familiar objects and events, were a response of the artist to the beauty and mystery that science beholds. The purpose of the event was to make topical scientific concepts and development appealing.

The proceedings began with President of the Indian Academy of Sciences, T. V. Ramakrishnan welcoming the participants. This was followed by a special lecture by J. N. Goswami (Physical Research Laboratory (PRL), Ahmedabad) titled 'Origin of the solar system: A cosmic accident?'. Goswami began his lecture by stating that the origin of the solar system is still a matter of intrigue and conjecture for many. Tracing the recent history of studying the solar system, Goswami stated that until 1960 the origin of solar systems was considered a two-step process. In 1969, when a broad understanding of the Nebula was enabled, the origin was understood as a natural process of formation of a sun-like star. A better understanding on the origin of the solar system was furthered in 1995 by Hubble.

As we discuss the origin and evolution of the solar system, the following questions are important: what caused the collapse of the protostar cloud, what is the timescale of collapse and what were some of the first solar-system grains, and what could have been the activity of the early sun and its effect on the nascent solar system and the processes, and the timescales governing the formation and differentiation of planetesimals and planets. And to derive answers to these questions, solar system objects that formed at different stages of solar system evolution need to be identified. The following chronology of events seems to be plausible to explain the origin: that the solar system is about 4.5 billion years old and short-lived nuclides with half-life of <100 MA that were present in the early solar system have now become extinct. Early solar system solids were rich in aluminum, of which ^{26}Al would decay *in situ*. Radio isotopes with half life of 0.1 to 1.5 MA must have been produced within a few million years prior to the formation of the solar system. And it is from this, the collapsed timescale can be inferred. Through an experimental approach of studying the sources of short-lived nuclides and the correlated presence of ^{26}Al and ^{41}Ca and ^{10}Be with canonical abundance in early solar system solids, it has been inferred that there was a triggered origin of the solar system, with a timescale of less than 1 MA. New results are in support of a stellar origin, and the plausible stellar sources could have been the Supernova, T10AGB star. Although it appears that the supernova triggered the collapse of the protosolar cloud, which could have been an accident, more robust evidence is needed to make a conclusive statement.

The first technical session comprised of four speakers. Yamuna Krishnan Ghosh (National Centre for Biological Sciences (NCBS), Bangalore) spoke on the new avatar (role) of the DNA. Her lecture focused on the new nanoscale perspective from which DNA could be viewed as a scaffold or construction material. She detailed some of her ongoing work on sequence complementarity and unusual forms of DNA.

B. N. Dev (Institute of Physics, Bhubaneswar) spoke on nanoscale magnetism and the role that ion beams can play. Magnetism in nano-structured systems is an important area of research wherein the utility of ion beams in modifying magnetic behaviour is being explored. While explaining the method of fabrication, Dev stated that in nanoscale magnetic structures, both the shape and size matter. The lecture focused on aspects of ion irradiation induced atomic displacement and migration, loss of magnetism in a ferromagnetic system and the evolution of ferromagnetism in a non-magnetic system. Highlighting the dual role of ion irradiation in creating and destroying magnetism, Dev spoke of the potential uses of the process in developing high-density data storage devices such as the ferromagnetic dots for magnetic data storage, and the spin-valve single electron transistor that would be capable of detecting a single electron spin.

Amit Basak (Indian Institute of Technology (IIT), Kharagpur) spoke on the design, synthesis and reactivity of enediynes and related carbon-centred radical precursors. Starting his lecture with a taunting statement that the world is tired of 'radicals', Basak traced the history of interest in enediynes. The challenges and curiosities that are presented by his work were summarized as follows: To synthesize and study the reactivity of N-containing cyclic enediynes and how the reactivity compares with that of all-carbon framework. Secondly, to fuse a B-lactam ring onto the azaenediyne and find the locking ability of the small ring. To study if the metal ion acts as an activator is a good challenge, as would be the devising of a synthetic route to the nine-membered aza enediyne. The possibility of designing enediynes that can be activated by thiols, changes in pH and light, the effect of intra-molecular H-bonding or intra-molecular charge transfer reactions and whether an intramolecular cycloaddition or iodohydrin formation be used to activate an enediyne were the other challenges that were discussed by Basak. In conclusion, it was stated that the synthesis of nine- and ten-membered azaenediynes has been achieved and the reactivity demonstrated. In addition, the effect of chelation and various activation strategies has been designed and demonstrated.

In Soumitro Banerjee's (IIT, Kharagpur) lecture on 'Qualitative changes in dynamical status, theory and open problems', the first part was devoted to explaining the basics of dynamical systems, differential equations, state space and

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phase space, and trajectories. Most trajectories in nature or engineering are nonlinear, and linearity is a special quality. Nonlinear systems may exhibit numerous, complex dynamical behaviours. Banerjee also dealt at length on 'chaos', a completely deterministic, aperiodic waveform. Highlighting the importance of bifurcations as dynamical events, Banerjee explained bifurcation theory as an attempt to understand the mathematical mechanism that causes a qualitative change in the dynamic behaviour. The interest is to study the asymptotical stable orbits in dynamical systems and their response to changes in parameters, which is generally carried out by obtaining discrete time maps, and using Poincaré section method. Two questions that are basic and critical to the study of bifurcation are as follows: how does the system behaviour change with the change in parameters and how can observed bifurcations be explained? His significant contribution has been in the area of developing the mathematical theory of border collision bifurcations and applying the same to various fields of science and engineering.

In the second technical session, the first speaker was Anjan Kumar Gupta (IIT, Kanpur), who spoke on 'Some unusual electronic patterns on graphite surface'. His lecture was organized as follows: a brief introduction to electronic patterns followed by a detailed description of quantum tunneling, STM and STS, a detailed discussion on the Moiré pattern in graphite and real space Moire pattern, and electronic pattern due to buckling of layers.

Swarna Kanti Ghosh (Tata Institute of Fundamental Research (TIFR), Mumbai) spoke on the topic 'Through our Galaxy darkly', and focused on the following aspects: interstellar medium (ISM) and star formation in our galaxy, structure of the galactic disk and warp, and future areas of interest. Hubble's classification of the galaxy designates the galaxy that we are part of as spiral. Evidences for ISM in our galaxy are through the reflection nebula, emission nebula and the dark head nebula. On the question of how much of ISM is present, it was stated that it constitutes 10% of the total mass of which 99% is in the form of gas. About 1% is dust, which plays a crucial role by interacting with the local radiation field for redistribution of thermal energy. On the basic question of why study ISM, Ghosh stated that this is most critical to understand star formation, since ISM is in some sense the raw material for star formation. Ghosh also dealt at length with ISM in star-forming regions and the recycling of ISM and stars. Referring to the significance of the word 'darkly' in the title of the presentation, Ghosh said it was to emphasize the importance and methods of carrying out infrared observations. Ongoing work using the balloon-borne Far Infrared Telescopes built at TIFR and structural properties and warp signature of our galaxy were explained in brief. Ghosh concluded by highlighting the niche availability for Indian infrared astronomers.

Ramesh V. Sonti (Centre for Cellular and Molecular Biology, Hyderabad) spoke on 'Attack and defence in pathogen–plant interactions'. The lecture was structured not only to present some of the key results in the study of plant–pathogen interactions especially in rice, but also to highlight policy imperatives of such work. Sonti described his work as an integrated approach to understanding virulence, and explained in detail about the Type 2 secretion system which enables cell-wall degradation and Type 3 secretion system which is the plant defence. Type 2 secretion system, wherein four proteins are secreted, is important for understanding and handling XOO virulence. Each of the proteins thus secreted is required for inducing or releasing plant defence operations. XOO virulence has the capability to suppress defence systems, and this was demonstrated using controls and plants pre-treated with cellulose. By using Type 3 systems, the innate immune response of the plant is overplayed to override infestations, and this is typical of resistant-rice varieties. The lecture concluded with the importance of understanding plant–pathogen interaction in food crops to maximize yields, and the significance of conserving landraces.

Tushar Jana (University of Hyderabad) presented his work on 'Thermoreversible polybenzimidazole gel for polymer electrolyte membrane fuel cell'. Jana structured his lecture to include the following: the classification of gels, gel morphology study to understand structures using the Scanning Electron Microscopy, gelation kinetics and the preparation of phosphoric acid-doped meta-PBI membrane from the homogenous solution of the gels for high temperature polymer electrolyte membrane fuel cell application.

The first day's programme concluded with a public lecture by M. S. Narasimhan (TIFR Centre, Bangalore), who has recently been awarded the King Faisal Prize. Narasimhan's talk on 'What do mathematicians do, and how?' was an exposition of pedagogy. Mathematics, Narasimhan stated, is difficult to be explained especially in comparison to other sciences and mathematicians are often viewed with awe and amusement. Mathematics is an intellectual, yet useful activity that began with the study of numbers and shapes. It is a science of the intellect whose objects and modes of investigation are a creation of the mind. Attitude, method, content and nature of research motivate mathematicians, but it is often aesthetics that is a forceful impetus. Quoting Poincaré who said that aesthetics rather than logic is the dominant element in mathematical creativity, Narasimhan stated that the ability to search for beauty is a sure guide to discovery and 'seeing' a pattern is often the driving factor followed by the ability to interconnect. Elaborating on abstraction as the nature of mathematics, Narasimhan stated that abstraction refers to ideas or qualities rather than material objects, and mathematicians develop methods and techniques to study abstract concepts and structures. The biggest advantage that mathematics provides is the unification and organization of a large amount of material in an economic fashion. Although several mathematical notions arise out of nature and environment, there is also autonomous development and invention of concepts, as in negative and imaginary numbers. There are two broad kinds of mathematicians, viz. the problem-solvers and the theory-builders. Rather than the actual problem-solving, the processes and corollaries are more interesting in problem-solving and for theory-builders, the insights that are gained using the right dosage of abstraction is more appealing. Narasimhan dealt at length with the importance of proof in mathematics and the role played by proof in experimental verification. The conflict between discovery and proving, and the insistence of providing proof taking away the 'fun element' was also explained in detail.

The latter part of the lecture was devoted to explaining the interaction between mathematics and other fields of science. Citing Galileo who said that 'The book of nature is written in the language of mathematics', Narasimhan said that mathematics enables the application of knowledge gained to find answers to

concrete questions in a number of situations and helps in drawing upon the rich pool of scientific knowledge. Calling for a continued and enhanced interaction between mathematics and other sciences, Narasimhan concluded his presentation by recalling the words of H. G. Wells who said, 'When you solve a problem, be happy with the knowledge and some detachment'.

Proceedings of the second day began with a special lecture by K. Vijay Raghavan (NCBS, Bangalore), who spoke on the 'Development of locomotive ability'. He started the lecture dispelling a rather well-entrenched negative notion that exists about some of the mammals, notably ungulates. The fundamental question of how an organism knows that it needs a particular behaviour even before it experiences the need is the fundamental point of query. Other organisms that are being studied in this context are the fruit fly, lamp ray, leech and lobster. He presented in detail the study of behaviour and physiology, the Central Pattern Generator, nuclear determinants of behaviour and experiments on the physiology of coordinated movement. Tracing the history of development from a fertilized egg to the adult, Vijay Raghavan said that only 200 genes are known to generate patterns and these genes are conserved in structure and often in the context through evolution, and only five pathways control development. He also explained in brief the two types of approaches that are used to understand the relationship between genes and behaviour, viz. mutagenesis scans and studying specific neural circuits. The last part of the lecture was devoted to explaining the work on walking behaviour and footprint assay.

The first lecture in the III technical session was by A. Jayaraman (PRL, Ahmedabad), on 'Aerosols and their radiative forcing over India and surrounding ocean region – our present understanding'. Aerosols scatter and absorb solar radiation, alter cloud properties and modify the amount of rain and hence a study of aerosols has inherent economic considerations. Aerosols are customarily divided into primary aerosols (which constitutes the immediate layer) and secondary aerosols (which are typically fine and comprise the top layer). Fifty per cent of the secondary aerosols are man-made. The size of the aerosol is indicative of its chemical nature and hence the refractive indices will be different. Paradoxically, the effect of aerosols on climate is global although their presence is regional. Highlighting the effect of aerosols on climate, Jayaraman stated that it is relatively simple to study the effect of aerosols over sea which largely exhibits a South to North gradient in column. Soot particles present near the coastal region cause a higher extinction of incoming solar light and establish a gradient that is East–South. Describing the Indian coastline, Jayaraman stated that during winter, the Bay of Bengal is most polluted, largely due to the influence of the aerosols coming in from the South East Asian countries and mainland China. The lecture also included a detailed description of the vertical distribution of aerosols by using LIDAR. Jayaraman concluded by stating that the increasing aerosol amount over India can affect the summer monsoon in two ways, viz. by non-uniform heating of the atmosphere and by directly affecting cloud properties. Future domains of work would be a three-dimensional mapping of aerosols, the study of *in situ* aerosol cloud interaction and regional scale climate modelling.

Samaresh Bhattacharya (Jadavpur University, Kolkata) spoke on the 'Formation of metal–carbon bonds via C–H and C–C bond activation of selected organic molecules'. His lecture focused on the significance of the synthesis of organometallic complexes via bond activation. The lecture was a detailed description of the ongoing work of Bhattacharya, on the chemistry of complexes that are a result of the reactions between organic molecules and platinum.

Jitendra P. Khurana (University of Delhi, South Campus) presented his work on 'Sensory photoreceptors provide insight into plant vision'. Recent molecular genetic studies on *Arabidopsis*, yeast two-hybrid analysis and microarray technology have contributed to the identification of novel light signalling components and ascribing specific roles to phytochromes, cryptochromes and phototropins. Recent advances in genomics provide new opportunities for investigating light signalling networks in food crops such as rice, maize, etc. The presentation detailed recent work on characterizing cryptochrome 1 (CRY1) from *Brassica napus*. Creation of the ideal plant types, especially in useful plants was the focus of Khurana's presentation.

B. S. Ramakrishna (Christian Medical College, Vellore) spoke on 'The commensal flora of the gut and their influence on human health and disease'. The first part of the lecture was devoted to the description of the intestinal bacteria and the three critical functions that they perform, viz. protective, structural and metabolic. Protective functions include pathogen displacement, nutrient and receptor competition, production of antimicrobial factors such as lactic acid and bacteriocins, while structural functions enable barrier fortification and development of the immune system. Through their metabolic functions, the intestinal bacteria achieve synthesis of vitamins such as folate and biotin and also metabolize dietary carcinogens. The normal bacterial flora prevent gastrointestinal disease by inhibiting pathogenic infestation of enteric bacteria, improving epithelial and mucosal barrier integrity and altering immuno-regulation. Aggressive and pathogenic bacteria of the intestine include selected bacteroides, *Enterococcus faecalis*, pathogenic *Escherichia coli*, *Fusobacterium varium* and intestinal *Helicobacter*. Ramakrishna detailed the role of short-chain fatty acids in colonic disease, as in improving cell energy metabolism in colitis, effecting oral rehydration therapy by improving sodium and water absorption during diarrhoeal episodes, hastening epithelial recovery after injury and reducing inflammation in colitis. Elaborating on recent morbidity trends, Ramakrishna stated that as tuberculosis and other infectious diseases are on the wane, there is an increase in Crohn's disease, which is an overly aggressive cell-mediated response to luminal commensal bacteria in genetically susceptible individuals. The lecture concluded with Elie Metchnikoff's dictum of 1908 to replace putrefactive microbes in the intestine with a healthy flora of lactic acid bacteria.

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