

## Mid-year meet of the Indian Academy of Sciences

The President of the Indian Academy of Sciences, K. Kasturirangan began the proceedings of the Thirteenth Mid-Year Meeting of the Academy held in Bangalore during 5–6 July 2002 by highlighting salient achievements of the Academy, especially the efforts of the Science Education Panel (SEP) and the Academy's various publications. As part of the mid-year meeting, the SEP arranged a discussion on 4 July with invited teachers that focused on steps to improve the quality of science education. The teachers had an added opportunity to visit laboratories and interact with researchers in their own disciplines.

The opening special lecture on 'Novel atomic configurations in metallics' by S. Ranganathan (Indian Institute of Science, Bangalore) drew the 'golden thread link' between the past, present and the excit-

### Structure and space

Liquid  
Supercooled liquid  
Glass  
Quasicrystal  
Rational approximant  
Crystal



The golden thread of icosahedral order linking the structure of metallic liquids, glasses, quasicrystals and crystals.

ing future ahead in physical metallurgy. The practice of metallurgy in India has been of fine quality. Some remnants of glorious traditions in metallurgy are still evident through the stoic Iron Pillar at Delhi and the bronze icons of Thanjavur, Tamil Nadu. Wootz steel, capable of wide-ranging blend of useful properties had its origins in Karnataka State. It represents yet another example of India's contribution to this rich subject. In fact, the West attempted to try and uncover the secrets of Wootz steel, failed and stumbled on alloy steel instead. Modern-day physical metallurgists of India carry on this legacy with élan. The physical metallurgist is keen to pack space in a close-packed fashion. The first attempt in

this direction was in 1611 by Johannes Kepler who conjectured that the external form of snowflakes is controlled by their internal structure. The lecture outlined the foundations on which metallurgy is built, docking at the achievements of J. D. Bernal, Roger Penrose (Penrose tiling), William Hume-Rothery (solid-solutions and phase diagrams) and Linus Pauling (first intermetallics like magnesium stannide). Ranganathan also described his own work in the area of quasicrystals and nanocrystalline materials. D. Shechtman and co-workers in 1984 had first shown the possibility of ordered configurations existing without periodicity such as in the Al–Mn alloys. In 1985, S. Ramaseshan published in this journal, ideas emanating from new concepts in the architecture of solids. Ranganathan and his co-workers published their seminal work on quasicrystals in the Academy's own journals such as *Current Science* and *Pramana*. The definition of a crystal as 'periodic', prior to 1991, changed to 'any solid having essentially discrete diffraction pattern' – a revolution brought in by metallurgists in the definition of a crystal. Ranganathan dwelt on the properties and applications of bulk metallic glasses that had increased strength value and elasticity. These glasses display interesting mechanical, magnetic and chemical properties. Studies of structures of grain boundaries with periodic structure opened an entirely new field of investigation as did alloy design in high temperature aluminium and nickel alloys. In the distribution of knowledge in chemical systems, unaries were the best understood but it was quite the reverse for quaternaries where less than one per cent is understood. In 1981, Herbert Gleiter synthesized nanocrystals. Nanostructured materials have special properties arising due to a combination of size and the presence of a large density of atoms at grain boundaries. Ranganathan spoke of the link metallurgy had to other disciplines such as chemistry (clathrates) and biology (metallic helices), the challenges posed by the structure of liquids frozen into glass and the important link between structure and the space occupied. Ranganathan posed the possibility of the icosahedron playing

an important role in liquids and a 'beyond the quasicrystalline phase' in materials.

The second day of the meeting had an opening special lecture by S. M. Chitre (University of Mumbai, Mumbai) titled 'Seismic sun and solar neutrinos'. Chitre described the sun as the 'Rosetta stone of astronomy' and the sun as a 'cosmic laboratory' where a variety of physical processes could be studied. Is there an appliance that could pierce through the outer layers of a star and test the conditions within? A model of the sun could be inferred from looking at windows on the sun and its interior using sound waves as a tool. Dissecting the majestic sun in terms of its anatomy such as face of the sun, atmosphere and its internal constitution, Chitre dwelt on the sunspots whose magnetic field makes it exciting. Although accessing the interior of the sun directly for observations is not yet possible, Chitre said that it is however possible to construct a reasonable picture of the internal structure of the sun with the help of mathematical equations. These solar structure equations must, in turn, satisfy mechanical and thermal equilibrium and energy transport. For determining the accuracy of these numerically computed theoretical solar models and for assessing them, probes that can penetrate the outer layers of the sun and look at its interior are utilized. Solar neutrinos released by thermonuclear reaction in the sun and the waves generated through the bulk of the solar body like helioseismology are used as probes which have made seeing the inside of at least one star a reality, said Chitre. The helioseismic data have been analysed both by direct model fitting and by an inversion technique. However, it has not been possible to identify gravity modes in the sun as yet. Chitre then described the work of the Global Oscillation Network Group (GONG) where Indian efforts such as those at Udaipur, the Physical Research Laboratory (Ahmedabad) and the Indian Space Research Organization have contributed steadily in the last six years to following the sun through solar-neutrino experiments and for confirming the nature of the physics of nuclear reactions operating in the core of the sun. He also outlined the work of the Sudbury

Neutrino Observatory (SNO) that measured solar neutrinos.

In his public lecture, K. Anji Reddy (Founder of Dr Reddy's Research Foundation, Hyderabad) spoke of 'Science for profit is profit for science'. Where should funding for scientific pursuits come from? Is it from taxpayer's money or through business enterprises in novel drug discovery? Only by generation of funds from commercial enterprise could science in this century be sustained, said Reddy. He reiterated that 'both kinds of science' those for non-profit and those for profit could coexist, provided we understand that both are essential and mutually dependent and thus the apparent tension and cross purposes of the two kinds of science would disappear'. This, he added, would 'give way to a new and more healthy model of science that could also be more productive from the viewpoint of the taxpayer'.

Satyajit Mayor (National Centre for Biological Sciences, Bangalore) has been studying the endocytic pathways of molecules and their mechanisms in different cellular environments. Endocytosis is an important cell biology process whereby there is an uptake of molecules at the cell surface before being processed further. It is a process of interest to applications in drug delivery and therapeutics to the interiors of cells. In his talk, 'Functional and structural characterization of membrane raft in living cells', Mayor described his laboratory's interests which include endocytic traffic of GPI-anchored proteins, establishment of a genetic system to study endocytosis and the study of antigen-presenting pathways in antigen-presenting cells. The structure of membrane lipids has shown that both protein and lipid components of the bilayer are oriented anisotropically. Glycosylphosphatidylinositol-anchored proteins (GPIAP) are a set of proteins with functional diversity but having an identical membrane anchor, the GPI-core structure. GPIAP have a distinct endocytic process that is lipid-dependent. The structure in membranes of living cells possesses a dynamic-enriched clustering of cholesterol and sphingolipid groups causing segregated domains or rafts. Understanding the domain structure and the role of lipids leads to knowing how cellular functions in sorting and signalling work, using tools such as image processing and quantitative fluorescence spectroscopy.

K. A. Balasubramanian (Christian Medical College and Hospital, Vellore) spoke on 'Is intestine "the motor" of distant organ injury in post-surgical complications?' The gastrointestinal tract plays an important function to absorb nutrients and the lining of the mucosa serves to prevent luminal bacteria from sullyng the internal environment. However the delicate balance is altered due to surgical stress or burn injuries to the body. He detailed the changes at the cellular level such as biochemical and functional alterations observed taking help from an animal model such as the rat. Stress due to surgery could result in increased production of oxygen-free radicals and the rat's defence mechanism of antioxidant enzymes were monitored over two time points – 60 min and 24 h. The experiments on the rat showed that the handling of the gut during the course of an abdominal surgery induced alterations in the intestine affecting enterocyte mitochondrial structure and function. Enzymes such as xanthine oxidase that play a mediatory role in surgical stress of the intestine could be inhibited by pretreatment of allopurinol or by nitric oxide. Even distant organs such as the lung could be damaged by surgical manipulation of the small intestine through oxidative stress. These studies could help in understanding acute respiratory syndrome and multiple organ failure that are the common cause of death in surgical intensive care units.

Srabani Taraphder (Indian Institute of Technology, Kharagpur) enumerated the age-old problem of understanding the energetics of proton transfer reactions. She described enzyme catalysed multi-step biochemical transformation reactions, protein dynamics and hydration. She has investigated the critical link and role that proteins such as cytochrome P450 had in processes that involved the long-range transport of an excess proton through a series of donor and acceptor pairs, as biological proton transfer reactions took place in and through proteins.

Namita Surolia (Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore) dwelt on the 'The Fab end of *Plasmodium* FAS and more'. Her research includes identification of novel targets in *P. falciparum* for developing new antimalarials. Triclosan (2,4,4'-trichloro-2'-hydroxy diphenyl ether), a widely used antibacterial was investigated for antimalarial activity. Triclosan inhibits

the Type II fatty acid synthesis (FAS) pathway. The inhibition by Triclosan is very rapid and displayed 'immediate effect'. For this study, Surolia has characterized the over-expression of *Plasmodium* Enoyl ACP-reductase (*FabI*) in *E. coli*.

Amoebiasis, caused by *Entamoeba histolytica*, a parasite that makes its home in the gut is under investigation by the group of Sudha Bhattacharya (Jawaharlal Nehru University, New Delhi). She spoke on 'Retrotransposons in *Entamoeba histolytica*: Parasitic DNA in a parasite' where her group has characterized a retrotransposon-like element and looked for the existence of other such elements that would indicate whether their origins are from the genome itself or from the human host.

'Calcium-mediated signalling in early plant development' such as in sandalwood has interested K. Sankara Rao (Indian Institute of Science, Bangalore). The study of events that govern early plant development as in embryo and seed development has shown a post-translational inhibition of calcium-dependent protein kinase (CDPK) expression during germination. CDPK has another important association with the detection and study of CDPK from sandalwood embryos. This indicates the importance of CDPK in calcium regulation and is considered important in oil accumulation. The same has been found true in the case of other species such as groundnut, sesame, cotton, sunflower and safflower as well.

'Experimental evolutionary biology: Testing evolutionary hypotheses in the laboratory' was the subject of the talk by Amitabh Joshi (Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore). Using laboratory systems such as fruit flies in subjecting replicate populations to specific selection regimes or by tracking traits, evolutionary hypotheses have been tested under controlled conditions as a dynamic process.

The 'New chemistry of phosphorus-based systems' by K. C. Kumara Swamy (University of Hyderabad, Hyderabad) described cycloaddition reactions, hydrogen bonding in phosphates and penta coordinate phosphorus that defy the familiar apicophilicity rules.

Inorganic chemistry, in particular coordination chemistry was highlighted by R. N. Mukherjee (Indian Institute of Technology, Kanpur) in 'a synthetic journey within the domain of classical coordina-

tion chemistry and bioinorganic chemistry' through presentation of the structure and properties of a variety of transition-metal complexes.

Achieving higher precision measurements in high energy physics while searching for the innermost structure of matter in the subnuclear domain such as leptons, quarks, bosons, etc. was explained by Sunanda Banerjee (Tata Institute of Fundamental Research, Mumbai). Experiments at the large electron-positron collider at CERN have tested 'even the quantum corrections as predicted by the Standard Model of particle physics', according to Banerjee. These collaborative experiments involved physicists from all over the world and had Indian scientists playing a significant role. He also detailed the high precision detectors that have been constructed for this experiment at TIFR.

K. S. Krishna (National Institute of Oceanography, Goa) outlined the nature of the lithosphere deformation obtained from geophysical data collected in the northeastern Indian Ocean. These studies throw insight into the ages of seismic sequences, the intraplate deformations

and the way the central Indian Ocean lithosphere had changed over time, from the ongoing collision of plates of India with Asia. The oceanic response of folded mountains could also be correlated with the time of faulting.

Other topics covered were by: (a) Abhishek Dhar (Raman Research Institute, Bangalore) on 'Understanding transport in one-dimensional systems' with studies on heat transport based on statistical physics that enabled calculation of specific heat, compressibility, magnetic susceptibility starting from a microscopic description. (b) Vijay B. Shenoy (Indian Institute of Science, Bangalore) on 'Adhesion instabilities in soft films' and pattern formation. These experiments have implications on pattern transfer technology. (c) T. N. Venkataramana (Tata Institute of Fundamental Research, Mumbai) on 'Topics in discrete groups', a study of discrete groups of semi-simple Lie groups and their rigidity properties. (d) S. V. S. Murty (Physical Research Laboratory, Ahmedabad) on 'Mars and Earth: A comparative planetology'. He described the planets Mars and Earth and traced their evolutionary processes

through the study of nitrogen and noble gas isotopes in Martian meteorites and in Earth's mantle.

S. V. Dhurandhar (Inter-University Center for Astronomy and Astrophysics, Pune) spoke of 'Gravitational wave astronomy: A new window to the universe'. Detection of direct gravitational wave radiation is of interest to astrophysicists. With the advent of the construction of laser interferometric observatories and new improved detectors such as in the LIGO, VIRGO, GEO600, TAMA300 and AIGO500 projects and the space-based NASA-ESA mission, LISA that is to be ready in a decade, all of which are expected to lead to determination of gravitational waves that would revolutionize our understanding of the Universe. IUCAA is involved with the gravitational wave projects in various ways such as hierarchical methods for coalescing binaries, analysing outputs from network of detectors as in aperture synthesis etc.

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## MEETING REPORT

### Weather and climate modelling\*

Monsoon is an important phenomenon that influences various aspects of India to a great extent, including its economy. Since India has an agro-based economy, it is absolutely crucial and important that various facets of monsoon and the associated rains be predicted as realistically as possible. It is a challenging task to all scientists for developing and improving models for finally obtaining societal beneficial forecasts. These improvements are to be acquired at all time scales with an emphasis on the initial state of the atmosphere. In order to achieve this goal, any additional data that are assimilated in the analyses system for providing

the initial conditions for the model may improve the model performance. In addition, better skill can be obtained by improvement in the parametrization schemes of various physical processes. Increasing the resolution of models could resolve the orographic forcing, leading to a more realistic rainfall prediction. In the coming years, many new observations from satellites are going to be available in high-resolution all over the globe for use in modelling. India is also entering into an ambitious plan of launching various satellites with meteorological payloads. With development of proper assimilation technique the new satellite data could enhance the forecast capabilities.

The objective of the Indo-US workshop on Weather and Climate Modelling was to bring together the scientists involved in the areas of weather and climate modelling from both the countries for exchanging views and sharing experi-

ences as well as planning future work. S. V. Singh of NCMRWF and Dr B. B. Rath of the Naval Research Laboratory, USA, coordinated the workshop. Twelve scientists from USA belonging to six major establishments participated in the deliberations. Indian scientists from various organizations like India Meteorological Department, NCMRWF, Indian Institute of Tropical Meteorology, ISRO (SAC) and Indian Institute of Technology (Delhi and Roorkee) had participated. In addition, representatives from user community like Indian Air Force, Indian Navy, Snow and Avalanche Study Establishment and Indian Council of Agricultural Research (Central Research Institute for Dryland Agriculture), and various universities participated in the workshop. In all, there were about 120 delegates. The presentations and discussions were mainly confined to three broad themes, viz. (i) improvement of global analysis –

\*A report on the workshop on 'Weather and Climate Modelling' organized at NCMRWF, New Delhi during 7-9 February 2002 under the aegis of Indo-US Science & Technology Forum.