Pilgrims of science: Tirupati beckons Fellows of the Indian Academy of Sciences

The 67th Annual Meeting of the Indian Academy of Sciences (the second time since 1957) was held at the Sri Venkateswara University, Tirupati during 9–11 November 2001.

Delivering the presidential address, on 'S&T and imaging from space', the President of the Academy, Krishnaswamy Kasturirangan, Chairman, Indian Space Research Organization, said India had recently achieved the capability for remote sensing at a resolution of one metre. This is made possible by a catadioptic system that is combined with a linear array of CCD detectors and electronics of the STTL/FTTL type.

The Department of Space has for the first time evolved optics for state-of-the-art space cameras. The elements of electro-optic imaging system constitute the heart of the camera. This system is 'all reflective' with very little radiation loss. Image quality has been fine-tuned with the right type of mirrors. This has resulted in the successful building up of optics and mechanical assembly, 'top priority' components of a well-executed space camera.

Remote sensing has opened up new frontiers. It touches various disciplines in science and augments their efforts. Kasturirangan showed exactly how this is done. Various imaging modes are built into the space camera such as area-by-area, pixel-by-pixel or by line. The line-by-line approach covers the entire line in a 'push-broom' technology. This line-by-line mode enhances sensitivity by nearly four orders of magnitude compared to the other modes. What can be learnt from such imaging? Plenty of reliable quantitative information can be obtained. Remote sensing has opened 'a new vista of science' said Kasturirangan. However, he emphasized, 'all this calls for the expertise of a multidisciplinary team'. The Department of Space has been successfully accomplishing this by setting up a space cell in nearly every University, recruiting scientists directly from varied backgrounds, he added. The impacts such developments in instrumentation have had was made amply clear by pictures of remote sensing taken of parts of Bhubaneshwar, a riverine system near the same city and around the Nepal Himalayas. What are the possible applications of remote sensing in future? Among the several is firstly, getting reliable information of radiation emanating from the Earth's surface. This calls for modelling of the atmosphere and understanding the radiative interactions present in the atmosphere. There is a need to employ multispectral imaging and observations for arriving at n-dimensional systems. This is because natural systems are complex. This involves radiative transfer models, classification of algorithms and new approaches to artificial intelligence. Secondly, retrieving geophysical and biophysical parameters. Using ocean sensors, to look at 'signatures' of bioplankton distribution. Signatures are a key to space imagery and depend on the characteristic changes in the properties of the electromagnetic spectrum that is reflected or emitted from the target surface. However, these signatures are not completely determinable but can be inferred from spectral variation, polarization change, thermal inertia and temporal variations. Thirdly, development of instrumentation with use of ultra light-weight mirrors, adaptive optics, new optical materials, etc. will be an important activity.

The symposium on 'Radar and Microwave Remote Sensing in Atmospheric Science' had presentations from five speakers. One of the topics was: 'Global precipitation observation by spaceborne radar' by Kenji Nakamura (Nagoya University, Japan). He highlighted the essentials of the Global Precipitation Mission (GPM) proposed by NASA. The main objective is mapping over mid and high altitudes and studying the vertical structure of precipitation systems. This would address the impact of rainfall on climate variability and Earth's habitability. For the purpose of precipitation measurement on a global scale, satellite information with the help of spaceborne radar becomes a necessity. The TRMM satellite, launched in 1997 does just this. It obtains data crucial for observing precipitation in tropical regions and distribution of surface rainfall. The rain sensor on board provides data for a three-dimensional rain structure. TRMM is limited to plus or minus 38 degrees in latitude. It gives a three hourly rain distribution data over the globe thereby improving global analysis. Diurnal variation of precipitation is thus revealed. In the tropics, this could mean providing information of morning rain over the ocean, afternoon rain over land, variation of rain as a function of the distance from the coastline, etc. Scheduled for 2007, is the proposed launching of the ATMOS-A1 satellite. Its main task would be to observe precipitation structure including solid and liquid particles over most of the globe.

Jayaraman Srinivasan (Indian Institute of Science, Bangalore) gave an insight into 'Megha-Tropiques'. This is an Indo-French satellite for studying the atmospheric water cycle (water vapour, clouds, clouds condensed water, precipitation, and evaporation) and energy exchanges in the tropics. The joint development of the satellite is between the Indian Space Research Organization (ISRO) and the French Space Agency (CNES). The launching is set for 2005 using the Indian Polar Satellite Launch Vehicle (PSLV). It would operate at an altitude of 867 km and an inclination of 20 degrees. This would ensure at least four observations per day in the tropical regions. All this data would lead to meteorological applications. For example, prediction of tropical cyclones such as over the Bay of Bengal, and islands like the French Caribbean and La Reunion. Obtaining improved information of tropical processes, would in turn help seasonal forecasting of monsoons and the tropical rain season in general. Currently, with the available tools the frequency of observations from low orbiting satellites is inadequate. Satellites in geostationary orbits have carried sensors that operate in visible and infrared portions of the spectrum giving little understanding to what happens beneath the clouds. On the other hand, polar orbiting satellites are fitted with sensors operating in the microwave portion of the spectrum. These have disadvantages of low temporal sampling in the tropics. Megha-Tropiques would overcome these inadequacies by a combination of sensors that operate in the visible, infrared and microwave domains.

The National Mesosphere-Stratosphere-Troposphere (MST) Radar Facility is located at Gadanki. The features of the MST radar facility and its scientific utility were presented by P. Balarama Rao (MST facility) and D. Narayana Rao (S.V. University, Tirupati). The radar operates at a frequency of 53 MHz, has a peak power of 2.5 MW and is fitted with 1024 Yagi Antennas with an aperture of 130 × 130 m. The radar has a unique role in providing a vital link to globally operating networks of MST radars. Some of the data generated from the MST facility concern high resolution mapping of the vector wind fields, waves and turbulence, deduction of temperature profile from the wind spectrum, meteor trail observations, etc. The facility was visited by some of the fellows at the end of the Annual meeting.

Pravas R. Mahapatra (Indian Institute of Science, Bangalore) spoke on the multiparameter radar observation of the lower atmosphere. In the lower atmosphere, the strongest radar reflection comes from hydrometeors. The intensity of the local hydrometeor concentrations reflects on the strength of the radar echo. This in turn has correlation with rainfall, hail or snowfall intensity. Further, the power of the radar is made to act as an atmospheric remote sensor. These provide clues to distribution and various parameters of the scatterers present in the atmosphere.

Man is the target of agents of infectious diseases. Among the viral diseases, smallpox has been eradicated from the country and polio is on the verge of being eradicated; however there have been some sporadic new cases. Viral hepatitis is a major public health problem. Of the bacterial diseases, tuberculosis (TB) has not shown any decline in the pool of infection amongst the community and there has been a trend for increasing drug resistance in the type of infection prevailing in the country. Leprosy has shown epidemiological shift of cases per 10,000 population, decreasing from 38.1 cases reported in 1951 to 3.74 in 2000. Bacterial diseases of the gastrointestinal tract still pose a challenge to the country. Out of the communicable diseases, malaria has made resurgence with increasing level of insecticide resistance having developed in the malarial vectors in several parts of the country. The incidence of malaria from *Plasmodium falciparum* has risen to about 50% in the country as a whole. The HIV/AIDS infection presents a further challenge with about 3.86 million HIV infections in the country in the year 2000. The National AIDS Control Programme (NACP) of the Government of India launched in 1987 addresses broader issues in prevention and control. In the symposium on 'Challenges of Infectious Diseases' the speakers presented the challenges that face the country in this important area of public health and gave insights on ways to combat these diseases and the tools with which to do so. The present state-of-art in India for the development of diagnostic kits, vaccines and drugs for this purpose were amply illustrated. The speakers included Indira Nath, M. K. Bhan, S. K. Acharya, K. Srinath Reddy (all from All India Institute of Medical Sciences, New Delhi), P. R. Narayanan (Tuberculosis Research Centre, Chennai), and J. V. R. Prasada Rao (Ministry of Health and Family Welfare, Government of India). The future technologies for epidemiology and how India was facing up to the challenge from the point of medical research was laid bare by N. K. Ganguly (Director-General, Indian Council of Medical Research, New Delhi).

The two public lectures, 'Information science and molecular biology' by Albert Libchaber (Rockefeller University, New York) was a presentation that came from a deep interest in the history of science that charted the parallel development of molecular biology and information theory in the 1950s. The other, 'Science, history and anthropology – A perspective on Prof. D. D. Kosambi's works and their impact' by K. S. Singh (former Director-General of Anthropological Survey of India) was based on reflections that sprung from the speaker's own interaction with Kosambi. The special lecture by G. S. Agarwal (Physical Research Laboratory, Ahmedabad) on 'Controlling light by light-stoppage, storage and superluminal propagation of light' highlighted the research and applications of obtaining distortionless propagation of pulses even through an absorbing medium, by its appropriate management. This has led to the possibility 'to produce ultraslow light, store light in atomic coherences and to retrieve the light on demand, with coherent control being able to produce superluminal propagation of light'. The other special lecture on 'Soft computing, machine intelligence and data mining' by S. K. Pal (Indian Statistical Institute, Kolkata) explained the rigors of fuzzy set theoretical models that could be used in the recognition of speech, satellite imaging and even supporting unmanned space missions. The link between soft computing and its relation with machine intelligence and pattern recognition was explained. Neurofuzzy hybridization in computing would enhance performance, learning time and network size giving a new dimension to decision-making, with possible utility in medical and legal domains.

A special presentation by P. Krishnaiah (Tirumala Tirupati Devasthanams (TTD)) on 'Bio-aesthetic development of Tirumala Hills' was a trip into understanding the ecosystem that existed earlier in the Tirumala Hills and the measures being taken for arresting the denudation of forests and preserving the environment, trees and wildlife. For this, the entire forest area under the TTD of about 3050 hectares has been divided into 53 vanams. From these vanams, detailed data on soil etc. is collected and afforestation carried out using site-specific techniques. Conservation and propagation of medicinal plants is also an important aspect in the fight to preserving the ecosystem. Fire poses a danger to the forests and this has been dealt with by use of fire-walls and fire-lines preventing the spread of fire. Krishnaiah believes that 'after a period of 5–10 years, the Seven Hills of Tirumala will be re-clothed with luxurious green cover' in their entirety.

The lecture presentations by Fellows/Associates covered an array of topics such as protein stability, fluorescence approaches for studying molecular assemblies, molecular mimicry in biology, growth and properties of ultra-thin films, density functional theory, immobile plasticizer in flexible PVC, conductance in quantum wires and the 'pleasures of counting trees (graph theory)'. The other topics were Antarctica and a superb pictorial understanding of the wealth that needs to be conserved amidst the biogeography and biodiversity of the Himalayas.

Finally, a pause for thought. Could the 'symposium' structure have room for change? Perhaps. Suggestions to this effect (from Fellows) is that there could be an 'introductory talk' that preceded each symposium. This would lay the framework for the later 'nuts and bolts' to be presented by respective speakers. It would, in a nutshell, give a background to the topic of the symposium and explain salient details to an 'across the board' audience. This would in turn facilitate subsequent speakers to immediately go to the results of research, leaving adequate time for discussion. Further, each talk, in its structuring could perhaps begin with a set of conclusions. This would give emphasis and direction to a multidisciplinary audience leading to discussion and some carry-home thoughts. This, it is hoped would change the content of talks from being too bogged down with data and information that could be gleaned, if required, from appropriate sources.

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Asymmetric catalysis – A novel chemistry to win the Nobel Prize – 2001

The Nobel Prize in Chemistry for the year 2001 has been awarded one half to Karl Barry Sharpless, The Scripps Research Institute La Jolla, California, USA; and the other half has been equally shared by Ryoji Noyori, Nagoya University, Chika, Japan and William S. Knowles, previously at Monsanto Company, St. Louis, Missouri, USA. In fact, this year's award has been equally shared by the chemistry of asymmetric catalytic oxidation reaction and asymmetric catalytic hydrogenation reaction. Both these asymmetric reactions have influenced the world of chemical sciences for the last several decades; however, their impact has only been felt in the practical synthesis of several drugs and drug intermediates, vitamins, materials and other biologically active compounds during the last two decades.

In 1874, J. H. Van't Hoff (Nobel Laureate 1901) and J. A. LeBel independently discovered the tetrahedral arrangement of groups around the central carbon. If all the groups attached to the central carbon are different, the central carbon atom is said to be chiral. The word 'chiral' comes from the Greek word '*Cheir*', which means hand. Our left hand and right hand are like mirror images of each other and are not superimposable – the minimum criterion for chirality. So are most of the molecules of life. Most of the amino acids, peptides, proteins, enzymes, carbohydrates, nucleic acids like DNA, RNA or any naturally occurring biological catalysts are chiral. For example (*S*)-lactic acid found in milk is chiral (Figure 1).

All the enzymes in the cells are chiral. All the natural receptors in the cell prefer to bind one chiral form of the molecules called enantiomers. Hence, it is essential to produce one enantiomer in pure form. Each enantiomer is often expected to have a totally different effect on cells.

Several drug molecules are chiral. One of their enantiomers may have the desired therapeutic effect, whereas the other may be useless or even harmful. Similarly, several natural products used for various purposes may be chiral. Production of one enantiomer through a resolution would lead to an equal amount of the unwanted enantiomer which needs to be disposed-off or recycled. This process is not ecofriendly, nor it is economical. During the past few decades, research has been going on in developing methods for synthesizing one enantiomer rather than the other. However, the most economical way to prepare one of the enantiomers for industrial production would be through use of a catalyst which would behave like an enzyme, i.e. selectively make one desired enantiomer. Enzymes are small amounts of chiral material which would generate a large amount of chiral product from an achiral starting material. Scientists across the world have carried out intensive research to develop catalysts which could behave

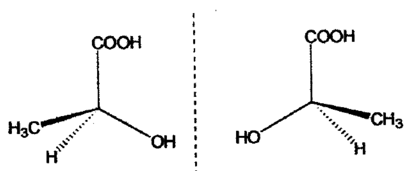

Figure 1. (*S*)-Lactic acid.

Sharpless' birthday celebration at his residence.

K. Barry Sharpless was born in Philadelphia in 1941. He got his BA in Dartmouth College (T. A. Spencer) in 1963 and Ph D at Stanford University (E. E. van Tamelen) in 1968. He did his postdoctoral research at Stanford University (J. P. Collman) in 1968 and moved to Harvard University to do further Postdoctoral work with K. A. Bloch. He joined the Chemistry Faculties in 1970 at MIT, Cambridge, USA.

Sharpless moved to Stanford University as full-time Professor in 1970 and continued till 1977. He rejoined the Department of Chemistry at MIT in 1980 and continued as Arthur C. Cope Professor till 1990. From 1990 onwards he joined The Scripps Research Institute, as W. M. Keck Professor, Skaggs Institute for Chemical Biology of TSRI, 1996. He has received various honours and awards.