Patrika

January 1991 No. 22 Newsletter of the Indian Academy of Sciences

56th Annual Meeting

At the invitation of the Utkal University and the Institute of Physics, Bhubaneswar, the 56th Annual Meeting of the Academy was held at Bhubaneswar from 8 to 11 November 1990.

The Meeting began with the inaugural function in the morning of Thursday 8 November, at the Maharaja K C Gajapathi Auditorium, Utkal University. Prof. T Pradhan, Vice-Chancellor, Utkal University, welcomed the delegates to the "City of Temples" and to Utkal University, and recalled how the Academy had held its 13th Annual Meeting in 1947 at Cuttack, at the invitation of Dr P Parija, a Foundation Fellow of the Academy and the first Vice-Chancellor of Utkal University. He said that the Academy is meeting in Orissa for a second time after 43 years, when Dr Parija's birth anniversary is being celebrated. Sri Yagya Datt Sharma, Chancellor, Utkal University and Governor of Orissa, then formally inaugurated the Meeting.

Prof. C N R Rao, President of the Academy, introduced the Fellows and Associates present to the audience. In his Presidential Address he spoke of "The Dative Bond" as understood from recent electron spectroscopic investigations.

There were two specialized symposia. The first symposium on *Food, Hunger and Nutrition in India* was held in the afternoon of 8 November at the Utkal University, under the chairmanship of Prof. C N R Rao. There were four excellent talks by L V Venkataraman, Central Food Technological Research Institute, Mysore on "The food prospects in India by the turn of the century", by Dr V Ramalingaswami, All India Institute of Medical Sciences, New Delhi on "The problem of nutrition now and in future", by G S Khush, International Rice Research Institute, Manila, Philippines on "New genetics and other technologies towards increased food production" and by N Rath, Indian School of Political Economy, Pune on "The economics of food, hunger and poverty".

Dr Venkataraman said that, despite the recent green, white and brown revolutions, unless every Indian has physical and economic access to food and enjoys food security, nutritional security and water security, he cannot be considered to be self-sufficient. Regarding the food strategy for 2000 A D, he said that energy-intensive, high-yielding varieties should be modified, changes in cropping patterns adopted to suit the soil and climate and new agricultural technology evolved to meet future needs.

Dr Khush pointed out that the population of India is increasing at a faster rate than the world population and faster than the rate of increase of food production by 2000 A D. Since there are no new areas suitable for food production in India, we need crop varieties with higher yield potential and better management practices. He said that recent advances in cellular and molecular genetics provide new tools which can be used for achieving specific breeding objectives.

Dr Ramalingaswami pointed out the two main paradoxes in India, where despite increased agricultural production and our advanced scientific capability, malnutrition is chronic and endemic, and the poor have not benefitted by the many developments in the country. He spoke of the diseases caused by micronutrient deficiency, iron, iodine and protein deficiencies, and suggested that unless we study malnutrition in all its aspects from molecular biology to its clinical and social aspects, and take effective action the problem will remain.

The evening lecture on 8 November was given by K V Soundara Rajan, Archaeological Survey of India, New Delhi, on "Art and architecture of early Kalinga". A summary of the lecture is published in this issue.

The second specialized symposium on *Physics with Accelerators* was held in the morning of 9 November 1990 in the auditorium of the Institute of Physics, under the chairmanship of

Dr T Pradhan. In his opening remarks he spoke of the history of the Institute of Physics and the experimental work done there, and the work the Institute proposes to carry out with the recently acquired Pelletron Accelerator.

P K Malhotra of the Tata Institute of Fundamental Research, Bombay spoke next on the "L3 Experiment at LEP and number of neutrino species". He described the Large Electron Positron Collider being set up in Switzerland and of the work which 38 laboratories from all over the world, including the Tata Institute of Fundamental Research, plan to accomplish with the 100–200 GeV LEP Collider.

B C Sinha, Variable Energy Cyclotron Centre, Calcutta spoke next on the "Relativistic and ultra-relativistic heavy ion collisions". He was followed by V S Ramamurthy, Institute of Physics, Bhubaneswar on "Nuclear physics with medium energy accelerators" and K P Gopinathan, Indira Gandhi Centre for Atomic Research, Kalpakkam on "Materials studies with charged particle beams".

There were twelve lecture presentations during the Meeting by new Fellows and Associates. The first series was held on the afternoon of 9 November at the Utkal University Auditorium, under the chairmanship of Dr S K Joshi. The first talk was by R Ramachandran, The Institute of Mathematical Sciences, Madras on "Spin statistics connection in two dimensions". The second was by D Dhar, Tata Institute of Fundamental Research, Bombay on "Self-organized criticality in nature". He spoke of theoretical models in which an open dissipative system organizes itself into a steady state showing power-law correlations, without need to fine-tune any parameters and the usefulness of the idea providing a framework for describing the ubiquitous power laws in nature. The third and last talk of the series was by S K Sikka, Bhabha Atomic Research Centre, Bombay on "Pressure-induced amorphization". He described how amorphous solids can be formed from the crystalline state, by application of pressure or compression, in addition to mechanical alloying, cold rolling etc.

The second series of lecture presentations was held in the late afternoon on 9 November under the chairmanship of Dr S S Jha. The first talk was by G Ganguly, Indian Association for the Cultivation of Science, Calcutta on "The advantages and limitations of amorphous silicon alloy materials for large area electronic devices". He listed the many advantages in hydrogenated amorphous silicon, such as low cost, large area uniformity, high photosensitivity and its many limitations, which, however, can be overcome by making it microcrystalline, using a combination of fluorine-based gases and annealing it out at room temperature using UV radiation.

The next talk was by P C Agrawal, Tata Institute of Fundamental Research, Bombay on "X-ray and optical studies of magnetized white dwarf binaries". He described how a white dwarf star in a binary possessing a strong magnetic field, becomes a spectacular source of soft X-rays and exhibits several other unusual characteristics in the optical and X-ray bands. Temporal and spectral studies of these sources, provide an insight into the radiation-emission processes, the nature of the compact object, the geometry of the system etc.

The last talk on 9 November was by V R Muthukkaruppan, Madurai Kamaraj University, Madurai on "CD2 and Leprosy". He spoke of how the CD2 molecule, a glyco protein present in all mature T-lymphocytes in humans, can be used to understand the mechanism of T-cell unresponsiveness in leprosy.

The evening lecture that day was given by Prof. J T Bonner, Princeton University, New Jersey and Raman Professor (1990–1991) on "Sociobiology — from insects to human beings". A brief abstract of his lecture is reproduced in this issue.

The third series of lecture presentations was on the morning of 11 November under the Chairmanship of Prof. C V Subramanian. The first speaker was R Gadagkar, Indian Institute of Science, Bangalore on "Towards an understanding of the origin of social life in insects". He spoke of his studies of the common Indian paper wasps and the results which point towards the important role for mutualism in the origin of eusociality.

C R Babu, University of Delhi, Delhi next spoke on "Systematics — a key science for tropics". Systematics deals with the classification and nomenclature of living organisms and their relationships, and is a key science for the tropics, where the economies are virtually based on the exploitation of living resources and where there is a need for ecological security.

The next two talks were by V Sitaramam, University of Poona, Pune on "Biological membrane structure and dynamics" and by C Ramakrishnan, Indian Institute of Science, Bangalore on "Protein structure: Analysis and modelling". These were followed by a talk by P K Sarkar, Indian Institute of Chemical Biology, Calcutta on "Thyroid hormones and brain development". The last talk of the day was by Rukhsana Chowdhury, Indian Institute of Chemical Biology, Calcutta on "Intracellular replication of choleraphage ϕ149" and of its immense taxonomic importance, as it serves to differentiate between the classical and *el tor* biotypes of *Vibrio cholerae*.

The Annual Meeting came to a close with concluding remarks by Dr S Varadarajan on 11 November.

A full day excursion to Puri and Konarak was organized on 10 November. The Business Meeting of Fellows was held at Hotel Toshali Sands, Puri on Saturday, 10 November after a visit to the Sun Temple at Konarak. Two short talks were given during the Business Meeting by Dr J C Bhattacharyya, who spoke of the Hubble Telescope Experiment, and by Dr Sharat Chandra, on the Human Genome.

There were two delightful evenings of music and dance, the first on 8 November, a beautiful Odissi Dance performance by the flawless genius Sanjukta Panigrahi and the second on 9 November, the vigorous, dynamic Chhow Dance of Mayurbhanj by Mayur Art Centre, Bhubaneswar. Both were held at the Soochana Bhawan.

The visit to the Regional Plant Resource Centre, with its unmatched collection of plants and trees, arranged on the afternoon of 11 November, was a rare pleasure to all the participants.

66 Fellows and 16 Associates attended the Meeting. The group photograph taken at Toshali Sands, Puri on 10 November is reproduced on pages 8 and 9.

The Bhubaneswar Meeting was one of the best organized of the Annual Meetings of the Academy. The organisation was magnificent and the arrangements for the scientific meetings, cultural events and excursions and for the accommodation of the delegates were superb.

Despite the difficulties many delegates had in reaching Bhubaneswar, due to rail and air transport dislocation, the excellence of the Annual Meeting and the generous and gracious hospitality of the hosts will never be forgotten by those fortunate enough to spend four days in this beautiful city of temples and the lovely State of Orissa.

The Academy is grateful to the Utkal University and the Institute of Physics, Bhubaneswar particularly to Dr T Pradhan, Vice-Chancellor of the Utkal University, to Dr V S Ramamurthy, Director, Institute of Physics and to Prof K Patnaik, Local Organizing Secretary, who made the 56th Annual Meeting the splendid success it was. Our special thanks are due to Prof C N R Rao and Dr V S Ramamurthy who organized the two symposia.

Honorary Fellows elected in 1990

J M Lehn, Institut Le Bel, Université Louis Pasteur, Strasbourg, France

H S Markl, President, Deutsche Forschungsgemeinschaft, Bonn, Germany

M J Rees, Plumian Professor of Astronomy and Experimental Philosophy, Institute of Astronomy, Cambridge, UK

Fellows elected in 1990

V H Arakeri, Indian Institute of Science, Bangalore, for his contributions to hydrodynamics, particularly cavitation

B Bagchi, Indian Institute of Science, Bangalore, for his theoretical studies of chemical kinetics and relaxation phenomena

K K Balasubramanian, Indian Institute of Technology, Madras, for his work on organic synthesis and reactions

K Banerjee, National Institute of Virology, Pune, for his studies in clinical virology

M Barma, Tata Institute of Fundamental Research, Bombay, for his contributions to condensed matter theory, particularly phase transitions

M K Bhan, All India Institute of Medical Sciences, New Delhi, for his studies of gastrointestinal infections in children

S K Brahmachari, Indian Institute of Science, Bangalore, for his work on the structure and functions of DNA

S R Gadre, University of Poona, Pune, for his theoretical studies on electron densities in atoms and molecules

S K Ghosh, Bhabha Atomic Research Centre, Bombay, for his work on quantum aspects of chemical reactivity and binding

H Ila, North-Eastern Hill University, Shillong, for her contributions to organic synthesis

J B Joshi, University of Bombay, Bombay, for his contributions to chemical engineering, particularly multifaced reactors

A V Khare, Institute of Physics, Bhubaneswar, for his studies of gauge theories in particle physics

G S Khush, International Rice Research Institute, Manila, Philippines, for his work on the genetic improvement of rice

K Kishore, Indian Institute of Science, Bangalore, for his work in polymer chemistry

H R Krishnamurthy, Indian Institute of Science, Bangalore, for his contributions to condensed matter theory, particularly magnetism

M Lakshmanan, Bharathidasan University, Tiruchirapalli, for his studies in nonlinear dynamics

K K Mahajan, National Physical Laboratory, New Delhi, for his contributions to ionospheric physics

Y V R K Prasad, Indian Institute of Science, Bangalore, for his contributions in materials processing and technology

G Prathap, National Aeronautical Laboratory, Bangalore, for his studies in engineering mechanics

V S Ramamurthy, Institute of Physics, Bhubaneswar, for his work in nuclear reaction physics

A Ramanathan, Tata Institute of Fundamental Research, Bombay, for his studies in algebraic geometry

Darshan Ranganathan, Indian Institute of Technology, Kanpur, for her work in reaction mechanisms and organic synthesis

V U Reddy, Indian Institute of Science, Bangalore, for his contributions to signal processing

Ashoke Sen, Tata Institute of Fundamental Research, Bombay, for his work in theoretical particle physics

G Shanmugam, Madurai Kamaraj University, Madurai, for his studies of cancer biology

R Simon, The Institute of Mathematical Sciences, Madras, for his work in theoretical optics

Y Singh, Banaras Hindu University, Varanasi, for his contributions in condensed matter physics, particularly liquids

A Sitaram, Indian Statistical Institute, Bangalore, for his work in harmonic analysis

A K Sood, Indian Institute of Science, Bangalore, for his experimental studies of light scattering

K V Subbarao, Indian Institute of Technology, Bombay, for his studies of volcanism

S V Subramanyam, Indian Institute of Science, Bangalore, for his work in experimental condensed matter physics, especially in one-dimensional systems.

V C Thakur, Wadia Institute of Himalayan Geology, Dehra Dun, for his contributions in Himalayan geology

Sociobiology

Summary of the Evening Lecture "Sociobiology — from insects to human beings" given by Prof. J T Bonner of Princeton University on 9 November 1990, at the 56th Annual Meeting of the Academy held at Bhubaneswar.

Sociobiology is defined as the study of social animals. Since all animals are social to some degree, there is a continuum from large, complex animal societies to ones that involve minimal interchange between individuals during courtship or during the rearing of offspring. If we look for the reason animals become more social, W D Hamilton (1964) suggested that there might be genetic advantages to group behaviour (kin selection), and in the mid – 1970's, with the publication of E O Wilson's book *Sociobiology*, there arose a great furore by Marxists, accusing Wilson of supporting the idea that social behaviour was genetically determined in human beings. This was an unjustified distortion of Wilson's views and now that the storm has receded, there has been an active pursuit of the study of social activity among animals.

Besides the genetic reason, animals can also gain in a number of activities through group effort, such as the more efficient gathering of food, the better protection of individuals, or the modification of the environment for the wellbeing of all the members of the group. In examining the characteristics of the more advanced social organisation among insects and vertebrates, one sees an increase in division of labour, an important role for dominance hierarchies, and an increase in the ability to recognize individuals or groups of individuals. In the case of the higher apes and human beings, there is another element that plays a role in the struggle for reproductive success. This is the ability of individuals to manipulate others to gain power. This idea is now called "Machiavellian intelligence" and it can be seen in many vertebrates, but it only became of central importance among the great apes and presumably in the ancestors of human beings. It is believed that this selection pressure for intelligence among primates has led to the great increase in brain size during the homonid evolution.

Kalinga Architecture

Summary of the Evening Lecture on "Art and architecture of early Kalinga" given by Dr K V Soundara Rajan on 8 November 1990, at the 56th Annual Meeting of the Academy held at Bhubaneswar

Kalinga, famous for its absorbing and individualistic architecture in its innumerable temples, was divided in the ancient past into three regions, variously called Utkala, Kongada (or Tosala) and Kalinga. Of these, the central part is the most notable for having been the capital zone and having generated temple art productions of unparalleled richness and beauty. The capital city of Kalinganagari was located close to the modern capital Bhubaneswar, represented by the ancient fortified site of Sisupalgarh. It was apparently from here that the great Kharavela of the Cheti or Mahameghavahana clan, the greatest king that Kalinga produced in the 2nd-Ist century B C, ruled. He has not only left rock-cut monuments, as at Khandagiri-Udayagiri, but also a unique historiographic account of every year of his thirteen-year rule, inscribed on the brow of the 'Hathi-gumpha' cave at Khandagiri.

Kalinga seems to have repeatedly attracted invasions from other kingdoms, probably because of its advantageous littoral situation, its rich mineral resources, the highly industrious rural folk and the virile and art-loving but equally leisure-loving urban gentry. The earliest invasion was by the Magadhama Nandas who are said to have taken away the cherished 'Kalinga Jina' or Mahavira icon. This was to be later retrieved by the redoubtable Kharavela. Then the Mauryan Emperor Ashoka embarked on a massive attack on Kalinga in the 8th year of his coronation. Such was the colossal loss of life, that in Ashoka's own estimate (recorded in his Edict) more than one hundred thousand elephants were killed or maimed (the elephant brigade of ancient Kalinga was justly famous) and in deep remorse he accepted the gospel of Ahimsa and compassion and became a Buddhist. He has left his now famous Edict inscriptions at Dhauli, not far from Bhubaneswar and at Jaugada in the Ganjam district. These contain instructions addressed to the Mahamatras (Viceroys) in Kalinga at Tosali (Kalinganagari).

The Imperial Guptas of Madhyadesa were the next to invade Kalinga in the 4th century A D; followed by Sasanka of Gaud (Bengal) in the 5th century, Pulakeshi II Chalukya of Badami (Karnataka) in the 7th century, the Imperial Cholas in the early medieval times, and finally later the Vijayanagara Emperor, Krishnadevaraya in the 16th century. Kalinga however kept its unity intact unscathed by all these conflicts and invasions and absorbed all that was great in the art of these invaders.

It was in the realm of architecture that Kalinga displayed its calibre, variegating the traditions of form and style in its architectural formulations, into the triple temple models — the 'Rekha deul' or the curvilinear towered form (similar to the pratihara temples of Kanauj), the 'Pidha deul' (or the tired indigenous folk creation generally associated with Devi shrine use and of the wood and bamboo prototypes) and lastly the 'Khakhara' (or the gourd-shell form of tower) for the divine mothercult (Sapta-matrs). Each of these three models was converted into several variants. The 'pidha' especially from its simpler forms evolved eventually into the ornate Jag-mohan axial front towered hall by about 1000 A D and thereafter was permanently wedded to the 'Rekha' or curvilinear form — a unison that is mentioned as the fusion of Siva and Shakti — as seen most picturesquely for the first time in the famous Lingaraja temple (cf. early 11th century). The 'Khakhara' was variegated into the Madhyadesa Valabhi type, the Chattisgarh Kosali type and the lower South Indian Dravidi of Tamil Nadu. These produced the great array of temples we see in Bhubaneswar, as the Svarnajalesvara, Lakshmana, Parasuramesvara, Vaital deul, Muktesvara, Sisiresvara, Brahmesvara, Bhaskaresvara, Lingaraja and the Anantha Vasudeva of the 13th century. Outside Tosala also, we have the varieties displayed at several places to the north and to the south. The two major architectural texts like Silpasarini and Bhuvanapradipa, list several scores of Rekha temples and many of the Khakhara types with their proportionate measurements in coded form for brevity. The Vaital deul temple at Bhubaneswar for the Sapta-Matrs is especially distinctive not only for its grandeur but also for the ritual offering of animal flesh till recent times.

The usual character of Orissan temple worship was the switching from one favourite cult to another, across the centuries, from the Pasupata Saivism in the 7th-8th century, the Sapta-matrs and Durga in the 8th-9th, the Agamic Panchayatana Saivism in the 10th century and to the Purushothama Vishnu Jagannatha cult as at Puri from the end of the 11th century. This last mentioned deity has since reigned supreme in the minds and hearts of the people of Orissa.

The solar association of Vishnu also resulted in Sun worship and the grandest Orissan temple for the Sun God came into being at Konarak, in the form of a solar chariot drawn by many horses. The idea however appears to have been taken by Narasimha, the ruler-builder, from the famous chariot mandapas of the Imperial Cholas, with whom this Choda-Ganga king had matrimonial alliances.

In the realm of art, minute and intricate surface ornamentation, like the silver filigree work of the Orissan lapidar, alasa kanyas, surasundaris and female musician groups, were the sublime creations of the talented Kalinga sculptors. These generally reached their climax, in the 10th-11th century A D as in the Raja Rani temple but became part of the favourite presentations on the temple walls. Erotic sculptures which are particularly seen in the Sun Temple at Konarak were essentially tantric and protective.

Orissan temple tradition, as in Tamil Nadu, is a living one, as temples following the ancient texts are being built even today. The skill of the architects and artisans in chiselling soft stones like Khondalites, Fluorite-Schists and other such building materials is outstanding and carving, finishing and minute decorations in traditional patterns and 'floral', vegetal and schematic designs are their speciality.

Orissa, noted for its Odissi style of dance, has been a great clearing house of aesthetic and architectural traditions and its past has been a saga of sublime art and spirituality.

Raman Professor

At the invitation of the Academy, Professor John T. Bonner, Professor of Biology, Princeton University, New Jersy, USA visited India as Raman Professor from 18 October 1990 to 4 January 1991. Soon after his arrival, he attended the 1990 Mahabaleswar Seminar on Modern Biology at Pachmarhi and the Annual Meeting of the Academy at Bhubaneswar. The last two months were spent at the Centre for Theoretical Studies, Indian Institute of Science, Bangalore.

Professor Bonner, one of the leading developmental biologists of our times, pioneered with K.B. Raper in the mid-1940s an entirely new field of study when he began to work on social amoebae (the cellular slime moulds). These studies, which he has been continuing ever since, have been marked by a seemingly unerring ability on his part to design and carry out simple but definitive experiments. Bonner's work has resulted in fundamental and widely acclaimed advances in our understanding of the various facets of the life of the slime moulds: their sensory biology, behaviour, and spatial patterning. His deep study of this microorganism led him to consider more general problems in developmental and evolutionary biology. The evolution of multicellularity and, going further, the evolution of social behaviour and culture, has engaged his interest in recent years. Characteristically, his entry into each of these areas has involved taking a fresh look at long-standing problems and the writing of a highly lauded book. In addition to being an acclaimed writer, he is a superb speaker. A brief summary of his evening lecture at the Annual Meeting of the Academy is reproduced in this issue.

Insect vision

Academy lecture on "A template theory for copying insect vision" by Prof G A Horridge of the Australian National University, Canberra, Australia on Monday, 29 October 1990 at the Indian Institute of Science, Bangalore.

Artificial visual processing technology is in a rather primitive stage. One reason for this is that our fascination with the marvel of human vision and the human eye, which is too complicated to copy, has prevented us from looking beyond, at a variety of simple visual systems in lower animals which are more convenient to copy. A second reason undoubtedly is our limited understanding of the visual systems of lower animals. Nevertheless, it is clear that the appropriate level of complexity to develop a technology for manoeuvring in a three-dimensional world is that of a generalized insect, which conveniently indicates one practical compromise between complexity, performance and ease of understanding. Unlike human vision, which depends on a large memory and rapid learning, insects get away with simple mechanisms by foregoing detailed analysis of pattern and categorizing objects into classes.

An artificial visual processing system, which reads the local spatial and temporal features into a computer code, so that any desired fraction of the features can subsequently be used as cues, avoiding the combinatorial labour of reconstructing the visual world as a map of 'objects', can be evolved by copying low-level natural vision such as that of insects.

Vision has evolved separately in lower animals such as marine worms, insects, octopus, spiders and fishes. The existence of many kinds of vision, adapted for different visual worlds and different visual behaviours, suggests that new mechanisms of natural vision that might be useful for 'simple' robots can be found which perform visual tasks,

even if we cannot yet copy man's visual system which categorizes objects before it presents them to our consciousness.

Vision in man can be described as a continual hallucination derived from memory, which is 'topped up' by the wandering fovea. By this means we can explain visions in dreams, visual illusions filling in at the blind spot, failures to notice errors, size constance, colour constancy, sharpness of edges in motion and categorization preceding consciousness, as in rapid reading. Even with existing supercomputers, it is at present not possible to construct a general purpose artificial seeing system with anything like this marvellous performance.

Coding Theory

Coding Theory, originating from an engineering problem of finding the best possible methods of encoding messages to be sent through communication systems and decoding them at the receiving end, has grown vastly in breadth and depth in the last four decades as one of the full-fledged fields of applied mathematics. The requirements of more sophisticated methods by practitioners of Coding Theory, such as engineers and computer scientists, working on telecommunication networks, construction of digital electronic instruments, cryptography etc. have enriched this field during this period with an inflow of many refined techniques from various fields of discrete mathematics.

A Discussion Meeting on "Combinatorics, Coding Theory and Computer Science", was therefore organized by the Academy at the Indian Institute of Science, Bangalore, on October 11–12, 1990 with the aim of providing an opportunity for the coding theoreticians to have a proper perspective of the problems faced by the practitioners of Coding Theory and for the latter to know the current developments in the field. About thirty mathematicians, engineers and computer scientists working in coding theory and related topics, from various research institutes, universities, government organisations and industries participated in this two-day meeting. The organizing committee members were S S Sane (University of Bombay), N M Singhi (TIFR, Bombay), G R Vijayakumar (TIFR, Bombay – Convenor) and K S Vijayan (ISI, Calcutta).

After the opening remarks by Prof. N Mukunda (Indian Institute of Science), the meeting was divided into two parallel sessions of lectures. Each participant spoke for about twenty minutes, each talk being followed by a brief discussion. The two opening lectures were given by G A Patwardhan (IIT, Bombay) and S S Rangachari (TIFR, Bombay), who spoke on "Some matrix transformations generating ternary designs and codes" and "Codes and lattices", respectively. The talks by M U Siddiqi (IIT, Kanpur) on "Using Galois switching functions in the study of error control codes" and by S S Sane (University of Bombay) on "Steiner systems in Coding Theory" outlined the methods of constructing codes by using respectively the 'Field theory' of algebra and the 'Design theory' of Combinatorics. Some of the other talks were on 'Linear codes' and 'Algebraic geometric codes' of Coding Theory and 'Projective planes', 'Reconstruction of graphs', 'Hypercubes' and 'Block designs' of Combinatorics. In one of the final lectures of the first day, C E Veni Madhavan (IISc, Bangalore) described some enumeration problems of algorithmic graph theory.

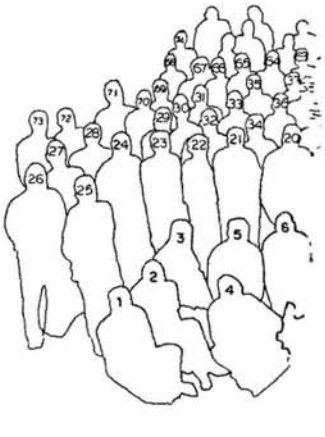
On the second day, N S Gopala Krishnan (University of Poona) spoke on "Primality testing based on elliptic curves" and P Pal Chaudhuri (IIT, Kharagpur) described some real-life applications of the "Theory of additive cellular automata". The other lectures covering a wide range of topics were on 'Tree packing', 'Root-lattices', and 'Generalizations of Hall's theorem' of Combinatorics, 'Simplex, optimum and perfect codes' of Coding Theory and 'Design of circuits' of Computer Science. In the evening, N Balasubramanian (CMC, New Delhi) gave a popular talk on 'Asymmetric ciphers' followed by K S Vijayan (ISI, Calcutta) on "Constructing perfect codes from 'nicely structured' graphs including the Peterson graph". The final talk of the day was by N M Singhi (TIFR, Bombay) on 'Unidirectional codes'. The central theme of most of the lectures was on the inter-relationship between Combinatorics, Coding Theory and Computer Science.

Trends in Theoretical Chemistry

A Discussion Meeting on Trends in Theoretical Chemistry, sponsored by the Academy, was held at the Indian Institute of Technology, Madras on September 30 – October 1, 1990. This was the second in the series of such meetings in theoretical chemistry sponsored by the Academy, the first having been held at Panjab University, Chandigarh in 1986. The purpose of the meeting was to bring active theoretical chemists together, so that their latest work could be discussed and

Participants at the 56th Annual Meeting held at Bhuan

1. S S Jha
2. Rama
3. V Sitaramam
4. S K Sikka
5. L M Patnaik
6. K L Chopra
7. S K Joshi
8. H Sharat Chandra
9. M S Kanungo
10. R Ramachandran
11. K K Kannan
12. L V Venkataraman
13. G K Manna
14. J C Bhattacharyya
15. B S Chauhan
16. H D Kumar
17. C Ramakrishnan
18. P K Malhotra
19. S Varadarajan
20. C N R Rao
21. J Barnabas
22. P K Jena
23. R G Rastogi
24. B R Murti
25. A Mani
26. S Ranganathan
27.
28. G Madhavan
29. P K Chattaraj
30. G Ganguly
31. C V Subramanian
32. N Kondal Rao
33. D N Bose
34. B Bagchi
35. A G Datta
36. S Mitra
37. S K Mishra
38. Probir Roy
39. U W Kenkare



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40. K Naha
41. V Krishnan
42. P V Kulkarni
43. D V S Jain
43a. D P Roy
44. P C Agrawal
45. P G Adyalkar
46. S Biswas
47. D Mukhopadhyay
48. P C Vaidya
49. B B Biswas
50. S K Bose
51. V S Ramamurthy
52. K B Misra
53. Rukhsana Chowdhury
54. Mrs J T Bonner
55. P K Sarkar
56. R Gadagkar
57. V R Muthukkaruppan
58. Mamata Satapathy
59. J T Bonner
60. T Pradhan
61. N Panchapakesan
62. R Srinivasan
63. R Nityananda
64. P Natarajan
65. R A Mashelkar
66. C Vedamurthy
67. Peter Jayaraj
68. M Rathnam
69. H O Agrawal
70. K Gopalan
71. L Satapathy
72. S K Ghosh
73. A B Roy
74. N Shariff
75. N Sethunathan
76. Avinash Khare
77. N Sathyamurthy

the direction for future work and co-operation among the theoretical chemists as well as experimentalists, physicists and mathematicians could be chalked out through in-depth discussions.

About thirtyfive invited participants attended the meeting. The sessions were organised on the basis of topics and each of the brief presentations in each session, was followed by extensive discussions.

The first session on "Statistical mechanics of condensed phases" opened with a review talk by R V Gopala Rao (Jadavpur University) on the statistical mechanics studies of equilibrium and non-equilibrium properties of liquids and solutions. He was followed by S Yashonath (IISc., Bangalore), who discussed the molecular dynamics simulation of a set of 64 diatomic particles interacting through a Lennard-Jones potential, and K L Sebastian (Cochin University), who spoke of the profile of diffusion of a single particle on the surface of a regular lattice.

The second session was devoted to "Density functional theory". S K Ghosh (BARC, Bombay) spoke of the development of a density functional theory for time-dependent systems characterized by external scalar and vector potentials.

The third session was on "Molecular structure". The speakers were A B Sannigrahi (IIT, Kharagpur), who introduced his definition of the multi-centre bond index, derivable from the SCF density matrix, E D Jemmis (University of Hyderabad), who showed how the diagonal relationship in the periodic table and the principle of isoglobal analogy could be used to predict the existence of unusual structures of organosilicon and siloboranes, S Ramasesha (IISc, Bangalore), who presented his method of theoretically modelling organic ferromagnets and M S Gopinathan (IIT, Madras), who described his modified version of the multiple scattering X-alpha theory for molecules, that takes into account relativistic and correlation effects.

The fourth session on "Interface of theory and experiment" dealt with theoretical work directly connected with the interpretation of experimental results. Anil Saran (TIFR, Bombay), spoke on quantum-mechanical PCILO studies on the conformation of anti-AIDS agent. P T Manoharan (IIT, Madras), presented MS-Xα and EHT results on the geometry and electronic transitions of the normal and metastable states of $Fe(CN)_5NO^{2-}$ ion. B Viswanathan (IIT, Madras), described how his model EHT calculations on hetaroply acids can be used to rationalize the Bronsted acidity in terms of the charge on the oxygen atom. S Subramanian (IIT, Madras) demonstrated that *ab initio* calculations at the minimal basis set level can give very satisfactory results for magnetic susceptibilities for molecules. P C Mishra, (Banaras Hindu University), presented both experimental results and quantum-mechanical calculations to prove that guanine can exist in two stable tautomeric forms, one of them corresponding to the form in the DNA and only one being able to complex with oxygen. These results have possible connections with carcinogenesis and photodynamic action. P C Deshmukh (IIT, Madras), spoke of the importance of electron correlation effects in atomic photoabsorption processes with special emphasis on autoionization resonances, while S R Gadre (University of Poona) gave a semi-popular evening lecture on "Bounds and parallel computing". He explained the great advantages of parallelization of programmes and the use of quantum-mechanical inequalities for speeding up *ab initio* computations.

The fifth session was devoted to "Molecular dynamics". B L Tembe (IIT, Bombay), showed how the dynamics of solvation in model systems could be studied by molecular dynamics simulation and how the relaxation times for time-dependent friction and for time-dependent cavity fields could be obtained. N Sathyamurthy (IIT, Kanpur), described the methodology involved in time-dependent quantal approach to reactive scattering. B Cherayil (IISc., Bangalore), spoke of his effective Hamiltonian approach to compute thermodynamic properties of polymer solutions, which exploits the similarities between polymer solutions and other molecular liquids. M K Mishra (IIT, Bombay), presented an update of his work on the role of potential structure in non-adiabatic collisions. The last two speakers were S Kumar, (IIT, Kanpur), who demonstrated the occurrence of fractals in atom-molecule collisions using rotationally inelastic HF-Li system as an example, and A K Mishra (CECRI, Karaikudi), who spoke of the use of many-body theory in computing binding energy and identifying the change of valence orbitals on adsorption.

The sixth session on "Development of computational formalisms" opened with a talk by P K Mukherjee (IACS, Calcutta), on a time-dependent perturbation theory for calculating doubly excited auto-ionizing states. S Pal (NCL, Pune), spoke of a variational cluster method, with the desirable features of size extensivity and satisfaction of Hellman-Feynmann theorem. K Bhattacharyya (University of Burdwan), described a sequential approach to divergent perturbation expansion. S P Bhattacharyya (IACS, Calcutta), presented the method of simulated annealing in electronic structure calculations which involves a global minimal search utilising metropolis algorithm at a sequence of temperatures. N Sukumar (Panjab University, Chandigarh), argued that using field-theoretic ideas, the quantum theory of radiationless

nonadiabatic processes can be reformulated in a manner analogous to that of radiative processes. D D Sarma (IISc, Bangalore), presented results of calculations on the electronic structure and metal-insulator phase diagram for CuO square planar lattice using a Hubbard model. S N Rai (NEHU, Shillong), outlined his calculations of reaction rates using quantum transition rate theory.

The last scientific session began with a talk by V Balakrishnan (IIT, Madras), on stochastic models of transport in disordered media. P K Chattaraj (IIT, Kharagpur), then spoke of how hydrodynamic versions of several classical nonlinear dynamical equations can be obtained and discussed the quantum equivalence of classical transition from toroidal motion to chaotic motion.

The final session was devoted to a general discussion on the status of theoretical chemistry in India and its possible future directions. Among the important points that emerged were:

1. The present situation, where theoretical chemistry and statistical mechanics are hardly taught nor is a subject of research in most State-level universities, should be urgently rectified. Modern syllabi and text books for the use of school and university students and teachers, should be prepared; workshops aimed at university students and teachers should be held and the lecture notes of these workshops published.
2. While no agreement was arrived at on the desirability of setting up a national computing facility, that could be used by those who do not have easy access to such facilities, there was general consensus on the desirability of setting up nation-wide computer networking facilities and a programme pool for sharing computer programmes.
3. Parallel computing and the use of transputers should be encouraged, and free market forces should be allowed to operate in the production and sale of transputers/parallel cards.

Special issues of Journals

1. *Proceedings — Earth and Planetary Sciences,* Vol 99, No 2, June 1990 — Special Issue on Structure and Tectonics: The Indian Scene.

Theoretical, experimental and field studies over the past three decades in structural geology and our new understanding of global tectonics have led to a considerable body of work describing the structural features on various scales both in peninsular India and the Himalaya.

This theme issue was prepared in the hope that a critical and incisive interpretation of the results of the study of the structure of the Indian land mass and its tectonic evolution would provide a reference volume for scholars in general and create an illuminating ground for testing new hypotheses.

The papers range from the tectonics of western Himalaya, Naga Hills and the Andamans, the Precambrian terrains of peninsular India, the southern Indian province, the eastern Indian province, the western Indian province, and the structure of the pre-Vindhyan metamorphic terrain of Rajasthan, to the geometry of thrust faults in the almost unmetamorphozed Pakhal rocks of younger proterozoic age.

2. *Proceedings — Chemical Sciences,* Vol 102, No 3, June 1990 — Special Issue on Modern Trends in Inorganic Chemistry.

A three-day symposium on Modern Trends in Inorganic Chemistry was held at the Tata Institute of Fundamental Research, Bombay, during 20–22 November 1989. The symposium was part of a biannual meeting of active inorganic chemists of the country and was aimed at focussing on the current status and future projections of research in the area of inorganic chemistry, both at the national and international levels. The symposium covered areas like bioinorganic chemistry, organometallic chemistry, inorganic photochemistry, solid state chemistry, electronic structure, chemical bonding and the synthesis, structure and reactivity of transition metal complexes.

The special issue includes twenty lectures delivered and abstracts of fortyfive posters presented at the symposium.

3. *Proceedings — Chemical Sciences,* Vol 102, No 5, October 1990 — Special Issue on Raman Spectroscopy and its Applications.

This special issue contains twentytwo contributed papers presented at the International Conference on Raman Spectroscopy, held at the Indian Association for the Cultivation of Science, Calcutta, during November 2–6, 1988, as part of the celebrations commemorating the Birth Centenary of Professor C V Raman and the Diamond Jubilee of the discovery of the Raman Effect.

The topics covered at the Conference included applications of Raman spectroscopy to biological systems, solid state systems, surface phenomena, resonance Raman spectroscopy, nonlinear Raman spectroscopy like CARS, time-resolved Raman scattering, high-resolution Raman spectroscopy and new developments in techniques and instrumentation. This special issue will help demonstrate the power and ever-increasing area of Raman spectroscopy in various interdisciplinary fields of research.

First Kodai Workshop

Under the auspices of the Academy, a Working Party on Optical Interferometry met at the Kodaikanal Observatory, from 10 to 17 August 1990. The aim of the meeting was to bring together radio and optical astronomers actively interested in this frontier area in observational astronomy. About forty scientists participated in the meeting.

Nine tutorial lectures covering various aspects of optical interferometry were given during the first three days on:
"Scientific importance of high angular resolution imaging" by P Venkatakrishnan (Indian Institute of Astrophysics, Bangalore)
"Present trends in optical interferometry" by N Udaya Shankar (Raman Research Institute, Bangalore)
"Image formation through turbulent media" by S Chatterji (Indian Institute of Astrophysics, Bangalore)
"Principles of synthesis imaging in radio astronomy" by K R Anantharamaiah (Raman Research Institute, Bangalore)
"Speckle interferometry" and "Speckle masking and triple correlation" by S N Karbelkar (Raman Research Institute, Bangalore)
"High angular resolution imaging at infrared wavelengths" by S N Tandon (IUCAA, Pune)
"Sensitivity limitations of high angular resolution techniques" by A P Rao (GMRT, Pune)
"Image restoration techniques" by R K Shevgaonkar (IIT, Bombay)

The Workshop began with the talk on the astronomical importance of high angular resolution observations at optical wavelengths. The discussions after the talk led to an unscheduled meeting on the importance of high spectral resolution studies. This was followed by talks on speckle interferometry and phase recovery schemes and on active and adaptive optics. Principles and techniques of radio interferometry applicable to optical wavelengths, such as synthesis imaging, self-calibration and deconvolution were also introduced.

In all there were six discussion sessions after the tutorial lectures, during the next three days. These were on: "Design considerations for an interferometric array at optical wavelengths", under the chairmanship of A P Rao. "Beam combining techniques", chaired by S N Tandon. "High angular resolution imaging at infrared wavelengths", under the chairmanship of J N Desai. "Instruments for high angular resolution imaging", chaired by N Udaya Shankar. "Seeing measurements", chaired by J C Bhattacharyya. "Current projects in optical interferometry", under the chairmanship of V Radhakrishnan. They covered in depth the design considerations for an interferometric array, instrumentation for diffraction limited and high angular resolution imaging and for seeing measurements. Myths about optical amplifiers, coherence, "Why not intensity interferometer" and sensitivity limitations due to scintillation were some of the topics covered during heated discussions.

All the participants stayed at the Observatory, enabling discussions to go on late into the night. A small library containing books and latest papers on optical interferometry, which was specially opened for this meeting, was an instant success.

The excellent arrangements by the Kodaikanal Observatory were greatly appreciated by all the participants and were mainly responsible for the undoubted success of the First Kodai Workshop of the Academy.

Obituaries

Cadambi Ambasankaran was born in 1923. He had his early education in the Madras University and obtained his Master's degree in Physics, from Christian College, Madras. After teaching physics for three years in Madras, he joined the Research Department of the Associated Electrical Industries in Manchester where he worked for several years. He was actively associated with the development of a 20 MeV linear accelerator at Harwell and a 300 MeV electron synchrotron at Glasgow. On his return to India in 1957, he joined the Department of Atomic Energy where he played a leading role in the developmental activities of the Electronics and Instrumentation Group. His first assignment was the development of an electron gun for the injection of a high current beam into a 5 MeV microwave linear accelerator. He then initiated a comprehensive programme in accelerators and high vacuum technology and related areas. He was Project Director of the Variable Energy Cyclotron Project and of the project "Studies on Magnetohydrodynamics for power generation".

His contributions to the development of science and technology covered a number of fields, such as high temperature and low temperature technology, vacuum technology, cryogenics, surface science, laser technology,

mass spectrometry, night vision devices, accelerators, magnetohydrodynamics, plasma science, electron beam technology and pulse power technology. He was an exceptionally good judge of persons and selected a large number of scientists, engineers and technical staff and nurtured them to achieve excellence in their chosen fields. In the fields of vacuum and ultra-high vacuum technologies, a wide range of components and devices, such as diffusion pumps, ion pumps, absorption pumps, thermal conductivity gauges, ionization and discharge gauges, leak detectors, vacuum control valves and vacuum fluids were developed. He played a pioneering role in making India self-sufficient in the field of vacuum technology leading to further advances in associated fields such as the manufacture of vacuum flasks, TV tubes and pharmaceuticals. He was instrumental in the forming of the Indian Vacuum Society and the organization of a number of courses at different levels to promote the training of personnel for the design, development, operation and maintenance of a variety of vacuum systems for different applications.

In the field of cryogenics, he was responsible for the development of cryostats, cryopumps, ultra-low temperature refrigeration systems, thermovac chambers, and even freeze drying of blood plasma needed during war. In the field of surface science, he encouraged the development of complex instruments like field emission and ion microscopes and Auger electron spectrometer for surface studies.

His efforts in the area of mass spectroscopy covered practically the whole range of the nuclear fuel cycle. He initiated work on the development of instruments for isotopic analysis of uranium in fuel and waste, of hydrogen in water, of nitrogen in enrichment studies and also argon in connection with geochronology. He initiated a programme for the development of night vision devices of vital importance to defence. This technology involved an integration of a complex mix of specialized techniques like infrared photo cathodes, high efficiency phosphors, electron optics and UHV seals. This development led to the establishment of a pilot plant facility at BARC and image converter tubes produced therein were supplied to defence to meet their immediate needs. This technology was finally successfully transferred to Bharat Electronics Limited for commercial production.

The Variable Energy Cyclotron Centre at Calcutta is a standing monument to his creative power and leadership qualities. It was the culmination of harmonious team-work between universities, research laboratories, public sector undertakings and government agencies.

Another of his important achievements was the setting up of a 5 MW MHD pilot plant at Tiruchirapalli, in collaboration with BHEL and sponsored by the Department of Science and Technology. Technical assistance was obtained from the Institute of High Temperature at Moscow. The MHD technology required expertise in the field of combustion engineering, seeding and seed recovery, magnet technology and material technology. In the field of plasma technology, his important contribution was towards the development of plasma spray and cutting torches, the technology of which was also transferred to industry. He seeded and catalysed the programmes on the development of electron beam equipment for metallurgical applications like melting, welding, refining and evaporation. These equipment developed at BARC are now finding wide applications in the Department of Atomic Energy for production of special materials at the Nuclear Fuel Complex, heavy water plants and reactor component fabrication. In the field of pulse power technology, he evolved programmes on nanosecond Gigawatt equipment which are now finding applications in defence and fusion-oriented research.

He was convinced that the translation of a laboratory prototype of a component or an instrument into a production prototype meant close interaction between scientists on the one side and industrialists on the other. He also believed that in addition to the transfer of documents concerning design and fabrication, the real success in technology transfer was possible only when the scientists responsible for the development of a technology item are also transferred to industry at least during the take off stage on the floor of the factory.

When the decision was taken to set up the Centre for Advanced Technology at Indore, Ambasankaran was appointed as the Chairman of the Planning and Implementation Committee. Under his dynamic leadership, work at this Centre progressed fast and the centre was formally inaugurated in 1984. He continued to provide technological consultancy to Indian industry to the end of his life.

He was elected Fellow of the Academy in 1972. He was awarded the Homi Bhabha Award for Research in Applied Sciences by the University Grants Commission in 1975 and the INSA Mahalanobis Medal in 1978. An outstanding human being, he loved people and the people in turn loved him. A fine work culture and harmony in team-work was hallmark of his leadership. He was fond of music, as he was

of plants. He had an excellent collection of rare orchid plants in his house.

He died at Agra on August 20, 1990, at the age of 67, while on a holiday. In his death, the scientific community in general, and BARC in particular, has lost one of its pioneers in the fields of technical physics and technology development, and for his many friends and colleagues a true friend and adviser.

Erwin Bünning was born in Hamburg on 23 January 1906. He went to school in Hamburg and is known to have read extensively even during his early years. He studied biology, physics, chemistry and philosophy at the Universities of Göttingen and Berlin from 1925 to 1928 and obtained his D Phil degree from Berlin University in 1929.

He worked first as Lecturer in the Universities of Frankfurt, Utrecht and Königsberg (now in the Soviet Union) and later as Reader (Dozent) at the University of Strasbourg. He became a Full Professor at the end of the Second World War in 1945 at the University of Cologne and accepted in 1946 the Wilhelm Pfeffer Chair for Plant Physiology at the University of Tübingen in 1946 where he stayed for the rest of his life.

Bünning had all the characteristic traits of the classical German Ordinarius Professors of his times, complete with the reputation of not being easily accessible. This image was further fortified by his being a man of few words who truly believed that 'anything worth saying can also be said briefly'. His own statements and writings were characterized by true economy of words. He was prophetic about several recent developments in research and teaching in biology. He was the prime mover in the matter of the famous institutes for Botany and Zoology at the University of Tübingen merging into their present form of Institut für Biologie I, II, III. He preferred to be called a biologist rather than a botanist. In this and other matters he was greatly influenced by the life and work of his role model Wilhelm Pfeffer (1845–1920) and he wrote an eminently engaging biography of Pfeffer.

The Nazis, after harassing him in the universities, forced him to join the German Army in 1939. In his own words 'my interest in this profession becomes clear from the fact that I never reached the rank of an officer'. Although this unfortunate war record was held against him all his life, his colleagues and scientists the world over, acknowledged his greatness and he was warmly welcomed after the war in UK, USA, Canada, France, the Netherlands, Switzerland, Australia, Japan, Pakistan and India.

He published about 260 papers in various fields of plant physiology and general biology, wrote the first monograph on the subject of biological rhythms, gave the first detailed account of the history of chronobiology in the form of 'the Chairman's Address' at the first 'Cold Spring Harbor Symposium on Biological Clocks' (1960) and a well-known textbook on plant physiology. When asked in 1981 by the National Academy of Sciences, USA, which of his discoveries he considered most important, his modest answer was "Experiments from 1929 to 1935 proving that certain biological 24 hour rhythms in plants and animals are endogenous and inherited. Also proving that, under constant conditions, the periods of these rhythms are not exact, but only about 24 hr (therefore now called circadian rhythms). I made during that time also the first cross-breeding experiments with strains of different periods. During these years and later I demonstrated that these rhythms have adaptive values, for example, for measuring the length of days (photoperiodism)". His entirely original idea that 'circadian rhythms act as yardsticks' in measuring seasons was first spelled out in his paper of 1936. This paper became a citation classic of *Current Contents* in 1982 and the idea conveyed in it is today known as Bünning's hypothesis. After his retirement in 1971, he was honoured by the University of Glasgow (1974), Freiburg (1977), Erlangen (1977) and Göttingen (1986) with doctorates *honoris causa*. He is a Fellow of seven academies including the National Academy of Sciences, Washington (Foreign Associate). He was elected Honorary Fellow of the Indian Academy of Sciences in 1986, which he wrote was to him 'a great honour and pleasure'.

Even though he was a 'northener' he dearly loved the Swabian town of the philosophers and muses, on the banks of the tranquil Neckar, Tübingen. He died in Tübingen three days after contracting pneumonia on 4 October 1990. He leaves behind his wife, two daughters and a son and many friends and students to mourn his loss.

Sachindra Nath Dasgupta, was born at Jalpaiguri in West Bengal on 4 November 1902. His early education was at Jalpaiguri Zilla School, Bangabasi College and Presidency College, Calcutta. He took his M.Sc. degree in Botany in 1925, from the University College of Science, Calcutta, winning the University Gold Medal. Subsequently he went to England for advanced studies in Botany. He received his mycological training under Prof. W Brown, and obtained the Ph D and D Sc Degrees from the Imperial College of Science and Technology, London. On his return to India in 1934, he joined Lucknow University as Reader in Botany. He became Professor and Head of the Department of Botany in 1950 and occupied that position till 1958, holding the additional responsibility of the Dean

of the Faculty of Science. During an intervening period of about three years (1947–50), he served as a Counsellor in the Agricultural Section of UNESCO at Paris. He worked as a Member of the Public Service Commission, West Bengal during 1958–60, after which he joined the Kalyani University as its first Vice-Chancellor, from which position he retired in 1968. In spite of failing eye-sight he could often be seen very busy with his portable typewriter amidst his collection of books and journals.

He established one of the finest schools of Mycology and Plant Pathology at Lucknow University. He also initiated taxonomic work of aquatic fungi, paper pulp mycology, effect of fungal enzymes etc. The 'tip necrosis disease of mango fruit' and its cause and control were successfully solved by his team of workers. On a request from the Indian Botanical Society, he prepared in 1958 the "History of Plant Pathology of India, Burma and Ceylon". Though basically a Mycologist and Plant Pathologist he had a broad vision and was thus responsible for the initiation and development of virology, plant physiology, lichenology and plant genetics in the Department of Botany, Lucknow University.

A Foundation Fellow of the Academy, he was President of the Indian Phytopathological Society in 1954, President of the Indian Botanical Society and of the Botany Section of the Indian Science Congress Association in 1956. He was conferred an honorary D Sc Degree from the Kalyani University in 1979. Active till the end, his last public lecture was given in 1982 to the Indian Phytopathological Society.

An ardent sportsman, he was good at tennis and badminton and spent his holidays trekking in the Himalaya.

He passed away on 11 September 1990 at Calcutta leaving a host of friends, students and admirers to mourn his loss.

Purushottam Kashinath Kelkar was born in 1909 at Dharwar, then in the Bombay Presidency. He passed away at Bombay on 23 October 1990. Early scholastic accomplishments enabled him to graduate with honours in physics and then secure a DIISc in Electrical Engineering in 1934 from the Indian Institute of Science, Bangalore. Three years later he was awarded the Degree of Doctor of Philosophy by the University of Liverpool. After a brief stint as a junior faculty member in the Department of Electrical Engineering of the Indian Institute of Science, he joined the Victoria Jubilee Technical Institute, Bombay in 1943, as Professor and Head of the Department of Electrical Engineering. The ensuing dozen years found in him a prolific innovator and a great teacher.

In 1956, he was selected by the Government of India as Planning Officer for the Indian Institute of Technology, Bombay. From this time he considered himself as an instrument for radically changing the profile of technical education in India. Latent convictions, rooted in originality of thought, creativity, deep insight and a power of abstraction, enabled him to succeed in even seemingly hopeless situations.

He set out to build IIT, Bombay, in borrowed quarters first in VJTI and later in the newly constructed building of the Silk and Art Silk Manufacturers (India) Research Association. By the time he had relinquished control of IITB as the chief Executive officer, he had recruited 80 faculty members within a mere 18 months!

His next task was establishing the Indian Institute of Technology, Kanpur. Beginning his work in a run-down cafetaria building at the Harcourt Butler Technological Institute, he overcame the impediments that incessantly arose in the structuring of the IITK, with the active co-operation of the Ministry, the participating American Universities and, the very young faculty and created a model for higher learning and research, that has withstood the test of time.

He was a deeply religious person and yet totally secular. He was able to blend our heritage and culture with the state-of-the-art technology. Many honours came his way, including the title of Padmabhushan conferred in 1970. These had little impact on him and to the very end he showed keen interest in all aspects relating to the generation of academic excellence and novel intellectual ideas. He firmly believed that the goal of the educational institution must be the pursuit of academic excellence and all institutions of higher learning must be totally autonomous. His only weakness, was his inability to foresee the emergence of new generations, where obsession with individual wellbeing would overshadow the larger goals for which he strived.

Charles Solomon Pichamuthu was born at Dindigul on 10 March 1900. His early education was at the Wesleyan Mission High School where his father was the headmaster. He stood first in all the examinations and joined the Central College, Bangalore, for higher studies in 1919. He owed his love of field work to his early training under Prof P Sampat Iyengar, an eminent geologist, from whom he learnt how to tackle geological problems both in the field and the laboratory.

Soon after graduation in 1921 he accepted the post of Assistant Geologist in Travancore, now part of Kerala. He remained there for six years and when a post of Assistant Professor of Geology at Central College, Bangalore, was advertised, he applied for it and was selected.

He went for higher studies to the University of Glasgow and came under the influence of two famous teachers of the day, Professors E B Bailey and G W Tyrell. Scottish geology was not very different from that of peninsular India and field trips under the guidance of these two masters enabled him to see things in a new light. He learnt the use of primary sedimentary structures for elucidating the structure and stratigraphy in folded Archaean terrains.

In Glasgow, instead of selecting a problem in that country like most other visiting students, he preferred to work on material brought from India. Quartzites, conglomerates and banded iron-formation of the Bababudan region, where he had worked earlier, had been regarded as originally igneous by the officers of the Mysore Geological Department. Convinced of their sedimentary character, he selected these rocks for detailed study. He contributed two papers, one on the Kaldurga conglomerate, and the other on the banded iron-formation of Bababudan. These two papers opened up a new trend in the study of Precambrian sediments. Glasgow University awarded him the Ph D degree in 1937 and D Sc degree in 1946. At about the same time he was elected a Fellow of the Royal Society of Edinburgh.

He returned to India in 1936 and started his field work with renewed vigour. Thus commenced his study of the Precambrian, which became for him a life-long journey of adventure. Convinced that the field was the proper place to teach geology, he took parties of students again and again to the same outcrops and re-examined them closely, making new observations each time.

His recognition of graded bedding in quartzites, intra-formational folds in iron-formations, pillow structures in Archaean lava flows, association of pink granites and charnockites, clouding of plagioclase in dyke rocks of the charnockite region, are some of the instances of his special powers of observation. The ten-year period from 1937–1947 was full of activity. In later years he used to recall this as the Golden Age of the Geology Department at Central College. In 1947, he was chosen President of the Geology Section of the Indian Science Congress and gave a clear and coherent account of the Precambrian geology of Mysore State. In 1948, he was selected as Director of the Mysore Geological Department.

"I was physically in this beautiful land which happens to be one of the oldest parts of the earth's crust composed as it is of geological formations many of which are as old as 3000 million years. The studies of these ancient rocks were thus a fascinating and exciting exploration into an inexhaustible past. It is difficult for a new geologist to realise the exhilaration of delving into the dawn of geological history and trying to reconstruct the conditions under which the Precambrian rocks of that period could possibly have been formed."

The two addresses which he delivered to the Mysore Geologists Association, one on the 'Granite problem' at Kemmanagundi and the other on the 'Charnockite problem' at Shimsha, were considered masterly reviews of the subjects. The main contribution of Pichamuthu to the Charnockite problem was his recognition of two types of Charnockites, an older variety which was gneissic or granulitic, formed by regional metamorphism of pre-existing schists and gneisses, and a younger one which was coarse-grained and granitic formed by anatexis. In 1972, he was awarded the Mysore Geologists Association Gold Medal in recognition of his contributions to Mysore Geology. He was also the recipient of the Pramatha Natha Bose Medal of the Asiatic Society in 1974.

In 1955, he retired from government service and worked for the next four years as Professor of Geology in the University of Malaya at Singapore.

In 1963, he joined as the Professor of Geology at the Andhra University and spent the next two years there. His wide knowledge of geological literature, his power of logical deduction and his ability to express his thoughts clearly and succinctly, enabled him to bring clarity where there was confusion before.

From 1972 to 1984, he was President of the Geological Society of India, an organisation which he had helped to found fourteen years ago. The D N Wadia Medal of the Indian National Science Academy was presented to him in 1988 in recognition of his significant contributions to the Precambrian Geology of India. His interests were not confined to geology. He loved cricket and chess. He was an active member of the YMCA and took part in various activities in the field of sports. "One of Nature's great gentleman", he was greatly respected and loved by all those who came to know him.

He passed away on 18 August 1990 at Bangalore after a brief illness.

Editor: Anna Mani
Published by G Srinivasan, Editor of Publications
for the Indian Academy of Sciences, Bangalore 560 080
and printed by him at the Eastern Press, Bangalore 560 029.