



# Patilka

January 1987 No.14 Newsletter of the Indian Academy of Sciences

## 52nd Annual Meeting

At the invitation of the Bānaras Hindu University, Varanasi, the 52nd Annual Meeting of the Academy was held in the BHU campus from Friday 7 to Monday 10 November 1986.

The Meeting began with the inaugural function in the newly completed University Auditorium, Swatantrata Bhavan, at 6 p.m. on Friday 7 November. The function started with the singing of the BHU Kulgeet by students of the University.

Prof. R P Rastogi, Vice-Chancellor of Banaras Hindu University and Chairman of the Local Organising Committee welcomed the delegates and guests. He said that it was the first time that the Academy, since its founding in 1934 was holding an Annual Meeting at Varanasi, although its illustrious Founder-President Professor CV Raman used to visit the BHU in the nineteen twenties and thirties to deliver lectures as an Honorary Professor of the University. He was confident that the Annual Meeting would serve as a catalyst in transforming the work of the University.

Professor Obaid Siddiqi, President, then introduced to the audience the Fellows and Associates present. He next gave the Presidential Address on "Biological Revolution." He traced the major developments in molecular biology, from the structure of DNA to information transfer and related these to the new types of questions being currently asked about the problems of development and differentiation, vision and the organization of the nervous system.

There were two specialised symposia and thirteen lecture presentations by new Fellows and Associates during the meeting.

The first symposium on '**Crustal Evolution**

**and Metallogeny in the Indian Subcontinent'** was held on the morning of Saturday 8 November 1986 in the Lecture Theatre of the Department of Mechanical Engineering, under the chairmanship of M S Srinivasan. The first talk was by V K Gaur of the National Geophysical Research Institute, Hyderabad on "Geophysical studies of the crustal structure". He was followed by R K Lal of BHU who spoke on "Precambrian crustal evolution". A K Gupta of the University of Allahabad next spoke on "The nature of the crust mantle boundary and the compositional variation of magma in the light of experimental evidence". The last talk of the Symposium was given by Supriya Roy on "Metallogenesis in relation to crustal evolution".

The first series of lecture presentations, under the chairmanship of O Siddiqi was held on 8 November. The first talk was by J P Mittal of the Bhabha Atomic Research Centre, Bombay on "Lasers in chemistry and chemistry in lasers". He was followed by K R Rao, also of BARC who spoke on the "Dynamics of atoms and molecular clusters in complex crystals". R Ramaswamy of the Jawaharlal Nehru University, New Delhi next spoke on "Chaotic behaviour in the eigenstates of molecular systems".

The evening lecture on 8 November was by N Mukunda of the Indian Institute of Science, Bangalore on the "**Mathematical style of modern physics**". A summary of the talk is reproduced in this issue.

The second Symposium on "**X-ray crystallography of biopolymers**" was held on the forenoon of Sunday 9 November under the chairmanship of S Ramaseshan. The first talk by V Sasisekharan of the Indian Institute of Science, Bangalore on "Structural variability of DNA: An X-ray diffraction study" was presented by P Parrack. He was followed by M Vijayan, also of the Indian Institute of Science, Bangalore, who spoke on the "Structure, transformation and interactions of proteins: An X-ray study". He described X-ray

studies of protein structures and some new results on structural transformations and interactions. The next talk was by K K Kannan of the Bhabha Atomic Research Centre, Bombay on "How drugs affect enzyme function: A protein crystallographic approach". He was followed by M Ramanadham, also of BARC, Bombay on "The significance of high precision in enzyme structures". The last talk of the symposium was by M R N Murthy of the Indian Institute of Science, Bangalore on "Structural studies on Belladonna mottle virus".

The special lecture by W Nultsch of the Der-Philipps-Universitat, Marburg, FRG was on "Photomovement of cyanobacteria". Cyanobacteria or blue-green algae, which invented the oxygenic photosynthesis, are mainly responsible for the generation of an oxidizing atmosphere in the early history of life. Since cells capable of oxygenic photosynthesis would be photodamaged or even killed in strong light, motile forms of algae and cyanobacteria have developed photosensing systems coupled to the movement apparatus, which enable them to avoid bright light and search out areas favourable for photosynthesis without damage. He described the two types of photosensory motor responses developed during its evolution.

The second series of lectures by Fellows and Associates was held in the afternoon of 9 November under the chairmanship of C V Subramanian. The first talk was by Surjit Singh of the Indian Institute of Technology, Madras on "Vibrational spectroscopic studies on structure of liquid water and aqueous solutions". The next talk was by D K Arora of Banaras Hindu University, Varanasi on the "Biological implications of soil solarization".

He was followed by R V Hosur of the Tata Institute of Fundamental Research, Bombay on "2D NMR: Crystallography in solution". He explained the recently developed 2D NMR technique, which provides structural information on biological molecules in solution. The next talk was by G R Desiraju of the University of Hyderabad, on "Crystal engineering a solid state Diels-Alder reaction".

The evening lecture on 9 November was by M S Valiathan of the Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum on "**The equatorial heart**". A summary of the lecture is reproduced in this issue.

The third series of lectures by new Fellows and Associates was held on the forenoon of Monday 10 November under the chairmanship

of V Radhakrishnan. The first talk was by S G Dani of the Tata Institute of Fundamental Research, Bombay on "Dynamics on homogeneous spaces and Diophantine approximation".

The next talk was by R Nityananda of the Raman Research Institute, Bangalore on "Corrugated wave fronts". He described the optics of wave propagation in a medium with random irregularities. The next talk was by S M Chitre of the Tata Institute of Fundamental Research, Bombay on "Gravitational mirages". The gravitational bending of light, predicted by Einstein's general theory of relativity, is responsible for the phenomena of gravitational lensing on cosmic scales, which leads to the production of virtual images of astronomical objects. This effect, already observed in the case of quasars as sources and galaxies as lensing systems, may prove to be a powerful tool in the study of our universe.

The next talk was by S Lele of the Banaras Hindu University, Varanasi on "Exploration of reciprocal space of imperfect solids". He was followed by N Sethunathan of the Central Rice Research Institute, Cuttack who spoke on "Microbial degradation of pesticides: Prospects and problems". The last talk of the series was by D Banerjee of the Defence Metallurgical Research Laboratory, Hyderabad, on "The metallurgical synthesis of titanium alloys".

The Business Meeting of the Fellows was held on the afternoon of 8 November. This was followed by a meeting of the President with the Associates present.

There were two cultural evenings organized on Friday 7 November and Sunday 9 November, with Yugal Bandi by Pandit Jotin Bhattacharya on the sarod and Prof. Dipak Chakravorty on the sitar, a violin recital by Smt. Sangita Shankar, a vocal recital by Pandit Channulal Mishra and a sitar recital by Smt. Krishna Chakravorti. There was also a Kathak dance recital by Smt. Jayantimala on 7 November, all of which were greatly enjoyed by the audience.

Excellent arrangements were made for the 52nd Annual Meeting held at Varanasi. The Academy is grateful to the Banaras Hindu University, to the Local Organizing Committee and specially to the Vice-Chancellor Prof. R P Rastogi for the excellent organization of the Annual Meeting. Our special thanks are also due to Prof. R K Lal and Prof. M V Vijayan for the organization of the two specialized symposia.

The 52nd Annual Meeting was attended by ninetyfour Fellows and twentyfive Associates. The group photograph taken during the meeting is reproduced on pages 6 and 7.

# Dr K Ramiah is ninetyfive

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India's phenomenal success in agriculture during the last two decades can be attributed to a great extent to the scientific contributions of a group of dedicated agricultural scientists, who began their work in the first decade of this century. The most prominent among them is Dr K Ramiah whose scientific contribution extended for over sixty years from 1914 to 1974.

Krishnasamy Ramiah was born on 15 April 1892 at Kilakarai, a small coastal town in Ramnad district of the erstwhile Madras Presidency. At the time of his birth, the term Genetics had not yet been coined. He was later to make substantial contributions to its growth and development.

After a brilliant career at the Agriculture College, Coimbatore, where he won gold medals for his academic performance, Ramiah joined as Research Assistant to the Economic Botanist of the College in 1914, where he worked on rice breeding for the next twentythree years, first under Parnell and later on his own, except for two years 1926-28, when he was deputed to Cambridge University for higher studies in Agriculture, with specialisation in Genetics. By research and course work, done under the brilliant biometrician Engledow, Ramiah obtained his post-graduate diploma in agriculture and an M.Sc from Cambridge University.

In 1930, he was appointed Paddy Specialist of the Madras Presidency. In that capacity he produced scores of new rice varieties, contributed to the genetics of rice and in general helped in increasing rice production in India. For his work Ramiah maintained a large collection of cultivated and wild rice varieties and also other species of the genus *Oryza*, to which rice belonged. Even at that early stage he realised the value of germplasm collection.

One outstanding investigation and achievement was the study of the genetics of blast incidence and resistance in rice. With the co-operation of mycologists, one variety CO-4 was identified as resistant to blast and used for hybridisation. This work was begun in the thirties and led to the evolution of CO-25, a blast-resistant variety which became the most common crop variety in the Cauvery delta till the seventies.

The first rice variety released by Ramiah was ADT 3, evolved by progeny line selection

from a local variety. It was characterised by high yield and early maturity and so it rapidly spread in the Cauvery delta and by 1960 had covered 2,00,000 hectares. However, his best known variety, in India and outside, is GEB 24. The original plant selected by Parnell was probably a natural hybrid. Ramiah's repeated trials at Regional Stations convinced him of its distinctly higher yield and superior grain quality. When finally released, it was welcomed by the farmers, millers and consumers alike, not only in the Madras Presidency, but in many other Indian States. It was widely cultivated in West African countries and is grown in Bangladesh as Niger Sail. It was the main variety of Karnataka known as Coimbatore Sanna. GEB 24 has been a good donor and was effectively used as a parent by rice breeders in India and the Philippines.

In the field of breeding, Parthasarathy and Ramiah were the first in India to initiate work on interspecific hybridisation. They also started work on the induction of mutations in rice through X-ray irradiation. In his cytological studies Ramiah was assisted by Parthasarathy and the late Ramanujam.

The rice plant offered a wealth of material for genetical studies, as the variations encountered in both the morphological and physiological characters are numerous. Ramiah published his results in 35 articles during 1917-54.

A significant event that took place in 1937 was the transfer of Ramiah's services as Geneticist and Botanist in the Institute of Plant Industry in Indore, for a period of 5 years. He had hoped to return to Madras as the Director of Agriculture. Since he found this was not likely to happen, he retired from Madras Government service and continued in Indore till 1945 and made some valuable contributions to the genetics of cotton.

Hutchinson and Ramiah standardised the description of the parts of the cotton and rice plants and published them with coloured plates and photographs, in the ICAR Monograph on "Rice Breeding and Genetics" (1953). A system of gene symbolisation for rice based on the model adopted in maize by Emerson *et al* was also formulated by Kadam and Ramiah. These publications are still widely used by rice scientists.

In his presidential address to the Agriculture Section of the Indian Science Congress held in 1941, Ramiah made a masterly survey of the plant breeding and genetics work done in India and indicated future lines of work.

In 1946, at the invitation of the Government of India, he helped establish the Central Rice

Research Institute, and served as its first Director till 1951. He chose Cuttack in Orissa for the first National Rice Institute and established in the CRRRI separate Divisions of Cytogenetics, Plant Breeding, Plant Physiology, Agronomy, Pathology, Entomology and Biometry which worked in close co-ordination with each other. The Institute provided in addition training facilities in rice science at the post-graduate level and enabled the trainees to obtain MSc and PhD degrees from Utkal University, Orissa. His scientific leadership and impartiality created an atmosphere of harmony that gave the young workers a sense of purpose and pride in their profession.

Realising that rice problems should be tackled, not merely at the national level, but at an international level, Ramiah suggested to the United Nations Food and Agriculture Organisation that a co-ordinated programme of rice breeding should be organized among the South and South-East Asian countries. This involved the production of new hybrids by crossing important local Indica varieties from different countries, with selected varieties from Japan, where the production per acre was the highest. The underlying idea was to combine the non-lodging straw and fertilizer response and therefore, high yield of the Japonicas with the medium and long, free-cooking grains of the Indicas, as also their resistance to blast disease.

This Indica-Japonica hybridization scheme was implemented at Cuttack and the resulting F<sub>1</sub> population supplied to the participating countries for further follow-up action under their soil climatic complex. A similar scheme for the various states of India was financed by the ICAR.

A major outcome of the Indica-Japonica project was the production of new hybrids such as Malinja and Mahsuri in Malaysia and ADT 27 in Madras State. The hybrid Mahsuri proved a great success in Andhra Pradesh and other Indian States, resulting in a substantial increase of production of high quality rice. Still more significant is the fact that the rice breeders of important Asiatic countries came together for the first time and benefitted by each other's experience.

During Ramiah's tenure at the Rice Research Institute, FAO invited him to join it as a Member of a Commission set up to review the agricultural situation in Thailand and to recommend measures to increase agricultural production in that country. He was also a Member of the Standing Advisory Committee (Agriculture) of the FAO, in which capacity, he attended its meetings in Copenhagen (1946), Geneva (1947) and Washington DC (1948). In

the same period he represented India at various meetings of the International Rice Commission in Thailand, Burma and Indonesia and was the Chairman of its Working Party in rice breeding.

Ramiah joined FAO in 1951 as Expert on Rice Production and Breeding stationed in Bangkok. He visited all the rice producing countries of South East Asia and brought about effective coordination in a programme of increasing rice production in the region, particularly after the end of the Second World War, when there was acute scarcity of rice. He helped FAO in the preparation of a World Catalogue of Genetic Stocks.

Ramiah's ideas of international co-operation in rice improvement led to the establishment of the International Rice Research Institute in the Philippines and its use of the dwarf variety found in Taiwan led to radical changes in rice breeding as for wheat.

Ramiah returned to India in 1957 and as ICAR Special Officer led a team that looked into the causes of low rice yields in Eastern Uttar Pradesh, Bihar and Orissa. Later, he served as a member of the Indo-American team to review the food production in India.

He also reviewed the working of the various Agricultural Research Institutes in the country.

In 1965, after completing his assignment with ICAR, he accepted the position of Vice-Chancellor of the Orissa University of Agriculture and Technology for a period of three years.

In 1968, in recognition of his scientific work, he was nominated to the Rajya Sabha, serving as an M.P. till 1974. He was a Member of a Parliamentary Committee that reviewed the working of CSIR Laboratories. He was also the Chairman of the Parliamentary Committee that studied the problems of agricultural labour.

In appreciation of his scientific work and the active role he played in scientific education, he was awarded the International Rice Year Medal (1961) and the Sunderlal Hora Medal of the Indian National Science Academy (1969). He was honoured with Padma Shri in 1955 and Padma Bhushan in 1970.

Ramiah is a foundation Fellow of the Indian Academy of Sciences. He was elected a Fellow of the Indian National Science Academy in 1942. We are sure all Fellows and Associates will join us in wishing him many more happy and active years.

# Honorary Fellows elected in 1986

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**BS Blumberg**, Fox Chase Cancer Center,  
Philadelphia, USA

**PHagenmuller**, Université de Bordeaux I,  
Talence Cedex, France

# Fellows elected in 1986

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**Anil Kumar**, Indian Institute of Science,  
Bangalore, for his work in the development of  
two-dimensional NMR techniques.

**R Balasubramanian**, Institute of Mathematical  
Sciences, Madras, for his contributions to  
number theory.

**AK Barua**, Indian Association for the  
Cultivation of Science, Calcutta, for his  
contributions to molecular physics and the  
physics and technology of amorphous silicon.

**Deepak Kumar**, University of Roorkee,  
Roorkee, for his theoretical work on  
magnetism and disordered systems.

**KP Gopinathan**, Indian Institute of Science,  
Bangalore, for his studies of chromosome  
structure and gene expression.

**CM Gupta**, Central Drug Research Institute,  
Lucknow, for his contributions in membrane  
biology.

**SK Gupta**, Indian Institute of Technology,  
Kanpur, for his work on condensation  
polymerisations.

**D Guptasarma**, National Geophysical  
Research Institute, Hyderabad, for his  
contributions to exploration geophysics and  
instrumentation.

**VK Kapahi**, TIFR Centre, Bangalore, for his  
contributions to observational radioastronomy  
and cosmology.

**GS Krishna Rao**, Indian Institute of Science,  
Bangalore, for his work on the chemistry of  
natural products.

**SK Mishra**, Indian Institute of Tropical  
Meteorology, Pune, for his contributions to  
monsoon meteorology.

**DMukherjee**, Indian Association for the

Cultivation of Science, Calcutta, for his work in  
quantum chemistry.

**MLMunjal**, Indian Institute of Science,  
Bangalore, for his work in aero-acoustics.

**Prem Narain**, Indian Agricultural Statistics  
Research Institute, New Delhi, for his studies  
on population genetics.

**PNatarajan**, University of Madras, Madras, for  
his contributions in photochemistry.

**MVNori**, Tata Institute of Fundamental  
Research, Bombay, for his work in algebraic  
geometry.

**GS Ranganath**, Raman Research Institute,  
Bangalore, for his contributions to the physics  
of liquid crystals.

**DP Roy**, Tata Institute of Fundamental  
Research, Bombay, for his studies in  
elementary particle physics.

**ASahni**, Panjab University, Chandigarh, for his  
work in palaeobiology.

**PVSane**, National Botanical Research Institute,  
Lucknow, for his studies of the chloroplast  
membrane.

**RP Sharma**, Regional Research Laboratory,  
Jorhat, for his contributions to the chemistry of  
natural products.

**ASurolia**, Indian Institute of Science, Bangalore,  
for his work on the biophysical chemistry of  
lectins.

**AK Susheela**, All India Institute of Medical  
Sciences, New Delhi, for her studies of  
fluorosis and its prevention.

**SK Tandon**, University of Delhi, Delhi, for his  
contributions in sedimentology, especially that  
relating to the Himalayan sedimentary basin.

**SN Tandon**, Tata Institute of Fundamental -  
Research, Bombay, for his work on cosmic rays  
and infrared astronomy.

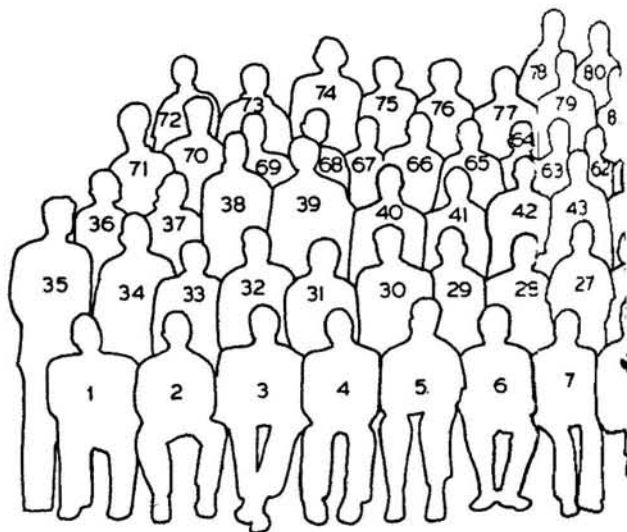
**MAL Thathachar**, Indian Institute of Science,  
Bangalore, for his contributions to systems  
science.

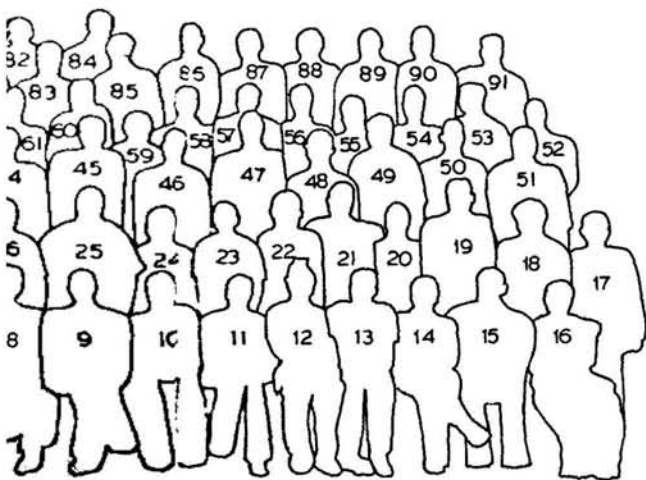
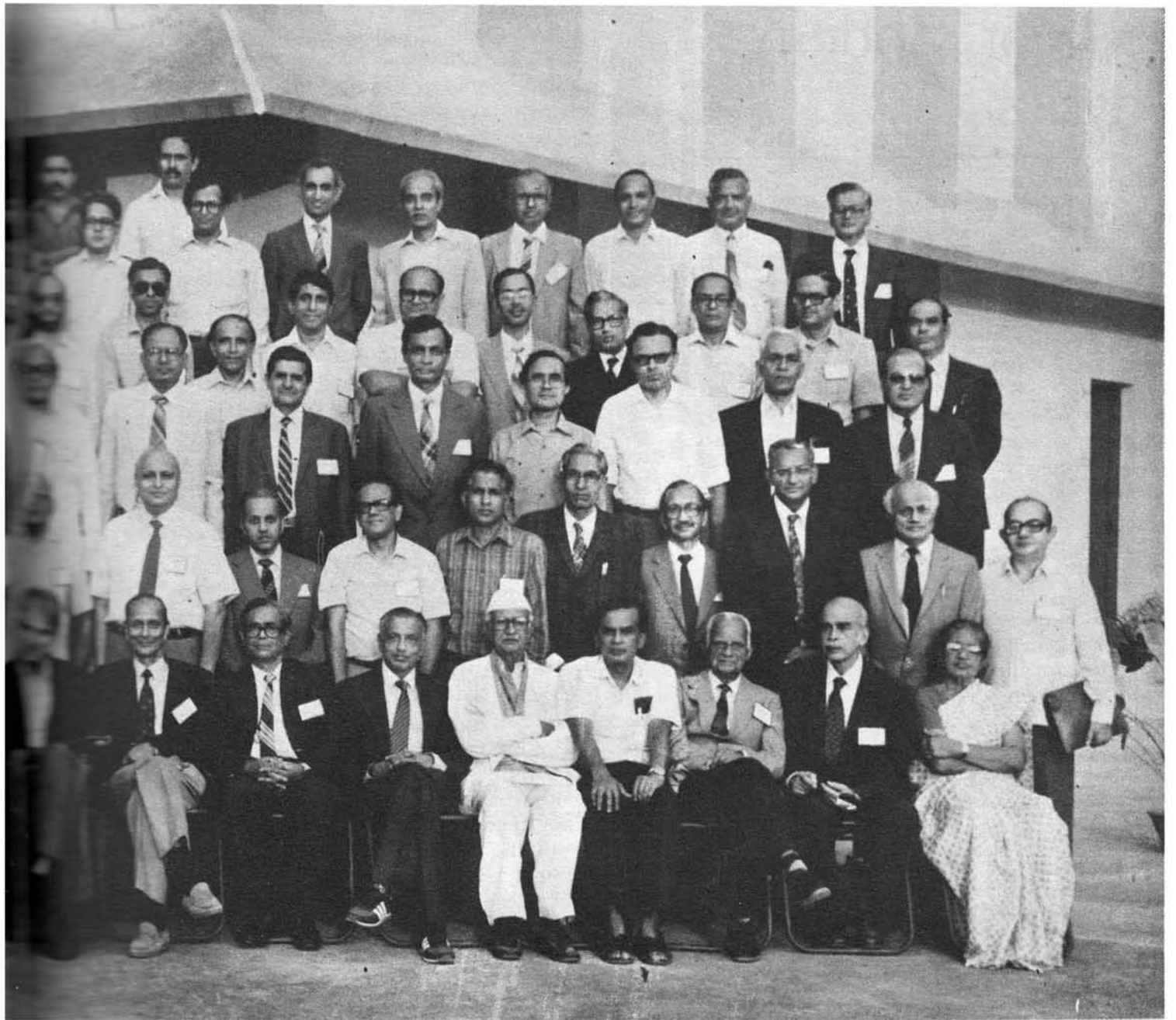
**N Viswanadham**, Indian Institute of Science,  
Bangalore, for his work in design of multi-  
variable control systems.

# Participants at the 52nd Annual Meeting Held at Varanasi



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|-----------------------|-------------------------|------------------------|
| 1. S. Paramasivan     | 16. Anna Mani           | 31. P. V. Kulkarni     |
| 2. K. Venkateswarlu   | 17. Supriya Roy         | 32. M. N. Rao          |
| 3. R. C. Paul         | 18. H. Y. Mohan Ram     | 33. R. N. Lakhanpal    |
| 4. M. R. A. Rao       | 19. T. C. Anand Kumar   | 34. J. S. Singh        |
| 5. W. Nultsch         | 20. B. A. Dasannacharya | 35. A. Chakravorty     |
| 6. T. R. Anantharaman | 21. P. G. Adyalkar      | 36. K. Shashikala      |
| 7. R. P. Rastogi      | 22. T. R. Kasturi       | 37. B. Krishna         |
| 8. O. Siddiqi         | 23. U. R. Ghatak        | 38. D. Balasubramanian |
| 9. S. Ramaseshan      | 24. K. R. Rao           | 39. V. K. Gaur         |
| 10. P. K. Jena        | 25. M. K. Mehta         | 40. B. C. Subba Rao    |
| 11. C. V. Subramanian | 26. C. Ambasankaran     | 41. R. Ananthkrishnan  |
| 12. P. C. Vaidya      | 27. P. Kumaraswamy      | 42. C. L. Mehta        |
| 13. M. S. Kanungo     | 28. D. D. Awasthi       | 43. J. P. Mittal       |
| 14. K. S. G. Doss     | 29. C. J. Saldanha      | 44. R. Chidambaram     |
| 15. Jagadish Shankar  | 30. B. L. K. Somayajulu | 45. S. Ranganathan     |





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|------------------------|------------------------|------------------------|
| 46. D. R. Sikka        | 61. I. V. Ramanuja Rao | 77. J. A. Sekhar       |
| 47. D. V. Singh        | 62. N. V. Madhusudana  | 78. Peter Jayaraj      |
| 48. D. Chakravorty     | 63. K. R. Shivanna     | 79. R. Nityananda      |
| 49. M. Vijayan         | 64. S. K. Gupta        | 80. M. S. Venugopal    |
| 50. L. K. Ramachandran | 65. VR. Muthukkaruppan | 81. J. Samuel          |
| 51. M. M. Taqui Khan   | 66. G. Padmanaban      | 82. L. Hanumanthappa   |
| 52. M. S. Srinivasan   | 67. B. M. Deb          | 83. M. Ramanadham      |
| 53. P. R. Adiga        | 68. C. R. Bhatia       | 84. G. Madhavan        |
| 54. D. D. Pant         | 70. P. V. S. Rao       | 85. K. K. Kannan       |
| 55. N. Sethunathan     | 71. Surjit Singh       | 86. G. Srinivasan      |
| 56. Ravi Mehrotra      | 72. M. Rathnam         | 87. H. Sharat Chandra  |
| 57. Sushil Kumar       | 73. L. K. Pandit       | 88. P. Ramachandra Rao |
| 58. K. P. Gopinathan   | 74. V. Radhakrishnan   | 89. S. Lele            |
| 59. P. K. Maitra       | 75. H. D. Kumar        | 90. R. K. Lal          |
| 60. N. Mukunda         | 76. S. G. Dani         | 91. C. Leelanandam     |

# The Mathematical Style of Modern Physics

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Summary of an evening lecture given by Prof. N Mukunda at the 52nd Annual Meeting of the Academy at Varanasi on 8 November 1986.

Prof. Mukunda began by reminding the audience of how physics is increasingly concerned with phenomena far removed from the human scale. This implies the use of more and more refined instruments but also of more and more abstract mathematics as a 'sixth sense' to replace intuition gathered from everyday experience. As Dirac has pointed out, we cannot be content with just refining a single group of mathematical ideas based on a few axioms. The mathematics needed by physicists continually shifts its foundations and becomes more abstract – for example, noncommutative algebra and non-Euclidean geometry, once regarded as curiosities, are an integral part of modern physics.

The major themes can be singled out in the mathematical style of modern physics – the use of symmetry and the inevitable use of unobservable quantities in the description of physical systems. The customary concept of symmetry is a static one in which the state of an object is left unchanged by some geometric transformations like rotations and reflections. This applies to symmetric patterns such as the arrangement of atoms in crystals. But the use of symmetry in physics goes beyond this static concept, because the dynamics, that is, the development of the system in time, is involved. A symmetry takes the entire history of the system and transforms it not into itself but into another possible history permitted by the basic laws. Initially, the laws were discovered first and the role of the symmetry principle was essentially descriptive. Two examples of this descriptive role are the Galilean transformations which describe the symmetry of Newtonian mechanics and the Lorentz transformations which describe the symmetry of Faraday and Maxwell's theory of the electromagnetic field. These symmetries include change to a uniformly moving frame of reference.

A deeper role for symmetry is what can be called restrictive. Here the symmetry principle comes first and restricts the allowed form of the physical laws. Einstein's concept of mass

energy equivalence originated from his efforts to make Newtonian mechanics consistent with the Lorentz transformations of special relativity. A remarkable example of the restrictive role of symmetry is given by Dirac's attempt to make the quantum theory of the electron consistent with relativistic symmetry. The spin of the electron, its magnetic moment and the existence of antiparticles all emerged as consequences and the equation explained more things than its discoverer could have hoped for.

This restrictive role of symmetry continues to be of great importance in the physics of elementary particles. The so-called weak interactions, responsible for some kinds of radioactivity, are a good example. The original theory given by Fermi was only one of five possibilities permitted by relativity. The later work by Lee and Yang dethroned the long-held belief that space reflection was a symmetry of nature and five more possibilities consistent with relativity had to be considered. The final solution given by Sudarshan and Marshak led to a unique form and a new symmetry known as chirality.

There is a third and even deeper level at which symmetry plays a role in physical theory. This can be called the creative role because it is no longer a question of just choosing or modifying a theory to be consistent with symmetry. The symmetry is in some sense the starting point and all but determines the final form of the theory. The examples of the creative role of symmetry involve the introduction of quantities which are not directly observable. An elementary example of unobservables is given by optics if we restrict ourselves to measurements of the intensity of light. It turns out that giving the intensity over a screen (for example) does not determine the further propagation of a light beam. One has to introduce a more general quantity called the two point correlation function of which the intensity is but a particular case. At a more fundamental level, one introduces scalar and vector potentials into classical electromagnetic theory even though the directly observable quantities are the electric and magnetic fields. This may be regarded just as a convenience until one considers the quantum theory. In this theory the price of eliminating the potentials is having to deal with non-local (path-dependent) quantities.

Einstein's theory of gravitation, also known as the general theory of relativity, is an outstanding example of the creative role of symmetry. In this instance, the symmetry which guided Einstein was the freedom to label the

points of space time with co-ordinates in any manner whatsoever. Clearly such a description has a large element of arbitrariness in it and the challenge is to separate what is physical from what is mere convention. A similar but perhaps less extreme arbitrariness enters into a whole class of theories proposed by Yang and Mills in 1954, which have since formed the basis for the modern unified theories of elementary particle physics. Two common characteristics of all such theories are (i) the equations do not fully determine the time evolution of the unobservable quantities (but of course do fix the evolution of observables) (ii) the initial conditions are subject to some restrictions or constraints.

The quantum description of nature uses mathematical quantities like wave functions which have some unobservable aspects to them. Contrary to popular impressions, much of modern physics rests on "constructs" which may not be directly observable but are nevertheless essential to varying degrees in expressing the theory in the simplest possible way. The nineteenth century tradition of making mechanical models of physical phenomena has been superseded by the spirit of the twentieth century, perhaps best represented by Dirac. He stated that nature's basic laws "...do not govern the world as it appears in our mental picture in any very direct way, but instead they control a substratum of which we cannot form a mental picture without introducing irrelevancies".

## 53rd and 54th Annual Meetings

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It has been decided to hold the 53rd Annual Meeting of the Academy at Hyderabad from 7-9 November 1987. The Council of the Academy has accepted an invitation from the National Geophysical Research Institute, Hyderabad to hold this meeting.

The 54th Annual Meeting of the Academy will be held at Calcutta in 1988. This meeting will coincide with the celebrations being planned in connection with the Birth Centenary of C V Raman.

## Equatorial Heart

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Summary of an evening lecture given by Prof. M S Valiathan at the 52nd Annual Meeting of the Academy at Varanasi on 9 November 1986.

The heart evokes as many different images as varied moods in the human mind. The comparative anatomist, the embryologist, the physiologist and the engineer will have his own distinctive view of the heart. But a philosopher might claim that all these images are merely schema of the heart, produced by the distinctive tools of each discipline. When the schema are added, the total is less than the reality which stalks behind the organ, unknown and perhaps unknowable.

In the welter of cardiac images, what is missed is the sensitivity of the heart to the geographic environment. Geography conditions the heart in health and disease just as the drone of the tamera conditions the music from the background. The heart responds to altitude, to climate, to the pull of the moon and sun and to the soil. But it is often a disease or dysfunction which reveals to us the subtle link between the cardiac melody and the geographical drone. It is in this nontraditional context that one must view the geochemical intimations of endomyocardial fibrosis, a type of heart disease which characterises the equatorial zone.

Endomyocardial fibrosis, which implies scarring of the inner lining of the heart, constitutes a fatal cardiac muscle disease in Nigeria, Uganda, Ivory Coast, Tanzania, Kerala, Brazil and Venezuela — all within 12° of the equator. The clinical profile of the disease is dominated as much by the young age of the victim as by the symptoms and signs of heart failure. The onset is insidious and patients are generally unable to date their symptoms to any acute illness. The disease runs an invariably fatal course with only 25 % alive at the end of two years of medical treatment. The central problem in the disease is the growth of a fibrous layer which gradually obliterates the pumping chambers of the heart. The fibrous mantle plasters the atrioventricular valves and restricts pumping function leading to intractable heart failure.

Laboratory investigations are necessary to confirm the diagnosis of endomyocardial fibrosis. Electrocardiogram while not specific may be marked by abnormal rhythms or diminished voltage. A far more important investigative method is ultrasonography which

has revolutionised the office diagnosis of endomyocardial fibrosis. Apart from demonstrating the structural changes, the two-dimensional echocardiographic technique can also reveal wall motion abnormalities of the heart. However, for a detailed demonstration of the anatomical lesions, cardiac catheterisation and selective cardiac angiography continue to remain the best methods.

At the structural level the endocardium is replaced by an excessively thick collagenous layer in endomyocardial fibrosis. As the disease progresses, the fibrosis extends into the subjacent myocardium and distorts the myocardial architecture.

Medical treatment can offer very little in this situation except managing the consequences of severe heart failure. However, excising the fibrous tissue from the ventricular chambers and replacing the non-functioning valve does produce significant palliation and 70% survival at the end of 5 years.

In the absence of a cure for the disease, a probe into its cause is imperative. The cause of endomyocardial fibrosis has, however, been a matter of debate ever since its recognition and many theories on causation have surfaced over the years. A widely held view at the present time is that endomyocardial fibrosis in the equatorial zone is the terminal phase of a disease known as hypereosinophilic syndrome in the temperate zone. According to this view, an abnormal increase in the number of eosinophils in blood and their breakdown lead to the release of a toxic protein from their granules which injures the lining of the heart and triggers the fibrotic process. This theory, however, leaves several questions unanswered, particularly the difference in clinical features between endomyocardial fibrosis and hypereosinophilic syndrome. A viable hypothesis on endomyocardial fibrosis must account for three cardinal preferences which characterise the disease. These are the preference for the equator, for the poor socioeconomic class and for the heart.

The interesting overlap in the incidence of endomyocardial fibrosis and the distribution of latosolic soil in the equatorial zone prompted a recent search for elements of laterite and monazite which might have replaced or displaced essential metal ions in the cardiac tissues of patients with endomyocardial fibrosis. A preliminary analysis showed that cardiac tissues of patients have less magnesium and more of calcium, sodium and thorium than the control samples. While the excess of sodium and calcium could be explained on the basis of congestive cardiac failure and reciprocal movement of calcium in relation to

magnesium, the deficiency of magnesium and the presence of thorium could not be readily explained.

Magnesium is an essential cation which has several functions including force development and relaxation, binding and release of calcium by sarcotubules and oxidative functions of the mitochondria. Magnesium deficiency is known to produce a variety of pathological changes in several organs. As patients with endomyocardial fibrosis suffer from malnutrition which is often associated with magnesium deficiency, it is entirely possible that magnesium deficiency observed in endomyocardial fibrosis is not accidental. But the highly cardioselective lesions of endomyocardial fibrosis would suggest that the changes induced by magnesium deficiency are modified or overshadowed by another factor in endomyocardial fibrosis.

Thorium is present in the monazite sands of Kerala and the latosolic soils of several other tropical areas of the world. It has been shown to be present in water and is concentrated by tuber crops which form the staple food of poor people in Kerala. Surveys have also shown the presence of thorium in the urine samples of children in this region. While thorium has no physiological role, it is possible that due to its strong positive charge, it binds to the phosphate of the membrane phospholipid and lipid bilayer of the sarcolemma. Thorium might have several possible modes of action at myocardial level. It could affect the binding of MgATP complex to myosin, trigger interaction of lytic enzymes in the cell, produce superoxide anions and other free radicals or act as a substitute for magnesium in cellular processes. Any of these actions or interactions could initiate the cellular injury which results in endomyocardial fibrosis.

A hypothesis based on magnesium-thorium interaction has the merit of accounting for the three cardinal preferences of endomyocardial fibrosis referred to earlier. In our view endomyocardial fibrosis is an equatorial aberration which is geochemical in origin. While only experimental demonstration can confirm or refute the hypothesis, the present view also opens up the exciting possibility of controlling or preventing the disease by simple means which are based on a fundamental understanding of the disease process.

# Obituary

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**Albert Szent-Gyorgyi**, one of the most remarkable biochemists of our century, died in Woods Hole, Massachusetts on 22 October 1986. Born on September 16, 1893, in Budapest, Hungary, he had started to study physiology at the University of Budapest, when he was called up for military service in World War I. In the post-war upheavals he wandered from one laboratory to another, learning new techniques from Michaelis and others, until he settled in Holland, first in Leiden and then with HJ Hamburger in Groningen. He became deeply interested in biological oxidations, especially the catalytic systems involving succinate, fumarate, malate and oxaloacetate. He recognized their wide general significance in metabolism, and his work represented an important preliminary step that helped toward the later demonstration of the total tricarboxylic acid cycle by Hans Krebs.

Szent-Gyorgyi also became interested in vegetable respiration, and detected a reducing agent, present in many plant juices, which he noted because it caused a slight delay in the progress of oxidations catalysed by peroxidases. That he took notice of this slight delay, which many investigators might have ignored, was characteristic. When Hamburger died, Sir Frederic Hopkins who had followed his work with interest, invited him to Cambridge and obtained a fellowship for him. Here he succeeded in isolating the reducing agent, which turned out to be the long-sought vitamin C. He called this substance ascorbid acid.

It was for his work on ascorbic acid that he received the Nobel Prize in 1937. The citation also noted the importance of his work on the role of dicarboxylic acid anions in biological oxidation systems.

Next he became involved in the study of muscle contraction and the proteins of muscle. On extracting myosin with salt solutions by the standard procedures, he noted that, if the extraction was prolonged, the extract became considerably more viscous, although the total amount of protein extracted was not much greater. This led to the recognition that another protein, later called actin, was associated with myosin. Szent-Gyorgyi's young co-worker FB Straub, purified actin, while he himself investigated the ATP-induced contractility of actomyosin threads.

From muscle research he turned to the problem of cell division. According to his

theory, the behaviour of the cell depends on the equilibrium of two substances, one which tries to make the cell multiply and one which inhibits this multiplication. He hoped to find a clue to the understanding of cancer by means of these substances.

Szent-Gyorgyi carried out this work which opened great new vistas in muscle biochemistry during World War II under constant danger from arrest. He escaped seizure by taking refuge first in the Swedish Legation in Budapest and later went into hiding until the war ended.

At the end of the war he left for the United States, where he settled at the Marine Biological Laboratory, Woods Hole, where he headed the Institute for Muscle Research.

Always ready to strike out into new fields, he became fired with interest in the concepts of quantum mechanics, although he never claimed to have mastered (or even to have actually grasped) the mathematical complexities of the subject. Along these lines, he wrote a *small monograph* on what he termed sub-molecular biology.

Szent-Gyorgyi took his MD from Budapest in 1917 and his PhD in Chemistry at Cambridge in 1927. He was elected an Honorary Fellow of the Academy in 1948, a Member of the US National Academy of Sciences in 1956 and of the American Academy of Arts and Science in 1957.

Szent-Gyorgyi reported on his work in more than 200 scientific papers and wrote several books, the first being *On Oxidation Fermentation, Vitamins, Health and Disease* (1940). His results on muscle were summed up in *Chemistry of Muscular Contraction* (1947); *Nature of Life: A Study of Muscle* (1948) and *Chemical Physiology of Contraction in Body and Heart Muscle* (1953). He wrote two books on *Quantum Mechanics, Bioenergetics* (1957) and *Introduction to a Submolecular Biology* (1960).

His major preoccupation during the last decades of his life, however, was with cancer. His views on the origin of cancer differed widely from those of almost all other workers in the field, but he continued research with a small group, and his last years must have been embittered with a sense of frustration.

He was always, especially in his earlier years, a man of infinite jest. Scientist and humanist, he was a unique and unforgettable man.

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