Patrika

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Golden Jubilee Celebrations

The golden Jubilee celebrations of the Academy, scheduled for 5 days from 7 to 11 November 1984 at Bangalore, had to be postponed due to the tragic death of Prime Minister Smt Indira Gandhi. She and the Government under her leadership had always actively supported and encouraged science and scientists in the country and in her death we have lost a valuable friend and a leader of great sympathy and understanding.

The Golden Jubilee Meeting will now be held for 3 days from 6 to 8 February 1985. Two symposia on Animal Communication and the Monsoons will be held during the Meeting.

The Academy Workshop on Supernovae, their Progenitors and Remnants was held as scheduled from 29 October to 2 November. A brief report on the Workshop will be published in the next issue of *Patrika*.

The tentative scientific programme for the Golden Jubilee Meeting is given below:

Wednesday 6 February 1985

Venue: Chowdaiah Memorial Hall

Inaugural Function

Presidential address

Golden Jubilee Lecture by S Chandrasekhar, University of Chicago, on *"The pursuit of science: its motivations"*

Special Lecture by M G K Menon, on *Cosmic ray research and cosmic ray physicists over the past fifty years in India*

Unveiling of Ramanujan bust at Raman Research Institute

Thursday 7 February 1985

Venue: Faculty Hall, Indian Institute of Science

Symposium on Animal Communication

Introduction—Madhav Gadgil

Communication, social behaviour and patterning in the cellular slime moulds—V Nanjundiah

Trade-offs in the evolution of frog vocalizations—A S Rand

Communication of kinship in social insects—R Gadagkar

Communication and synchronization of biological rhythms in insectivorous bats—M K Chandrashekaran

Lectures

Electron density in chemistry—S R Gadre

Structure, conformation and charge density studies by X-ray diffraction—T N Guru Row

Oncogenes: their function—L C Padhy

Special Lecture

Neurogenetics of smell—O Siddiqi

Business Meeting of Fellows

Friday 8 February 1985

Venue: Faculty Hall, Indian Institute of Science

Symposium on the Monsoons

Introduction—R Narasimha

The phenomenon—Sulochana Gadgil

The dynamics—P J Webster

Predictability—J Shukla

Special Lectures

Excursions into multiphase reactions—M M Sharma

What maketh a metal?—C N R Rao

Lectures

Biomimetic model reactions in photosynthesis—V Krishnan

Gene basis for drug metabolism—G Padmanaban

Spinning up a star—G Srinivasan

Special Golden Jubilee numbers of Proceedings—Earth and Planetary Sciences, Plant Sciences, Sādhanā (Engineering Sciences) and Journal of Biosciences and additional Golden Jubilee numbers of Proceedings—Chemical Sciences and Bulletin of Materials Science have been published.

The small illustrated book on "The Indian Academy of Sciences—the first fifty years" has been prepared and will be presented to all the participants as a memento on the occasion of the Golden Jubilee. Three cultural programmes have been planned during the Golden Jubilee celebrations.

The Academy is particularly anxious that all its Fellows and in particular all the Foundation Fellows should attend this meeting. The Foundation Fellows will be special guests of the Academy and the Council has decided that every Foundation Fellow could bring a companion, whose travelling expenses will be met by the Academy.

The travel expenses of all Fellows attending the Meeting, who are not able to obtain travel support from other sources, will be met by the Academy as in previous years.

During the period of the Annual Meeting of the Academy, the Chairmen of the Editorial Boards will also convene meetings of their respective Editorial Boards to discuss matters relating to the Academy journals.

Gravitational collapse and the problem of singularities in general relativity

Academy lecture given by Prof. S Chandrasekhar on November 21, 1984 at the International Symposium on Theoretical Physics in honour of S N Bose.

Prof. Chandrasekhar began by stating a basic theorem given twenty years ago by Roger Penrose: singularities are generic in general relativity. Much of the lecture was devoted to explaining the content and implications of this theorem and giving examples of its operation. To start with, he took a spherically symmetric cloud of matter with zero pressure, obeying Newton's laws of motion and gravitation. After moving radially for a finite time, the matter forms a region of infinite density at the centre. This is an example of a singularity but one that is not generic. The slightest deviation from spherical symmetry or the introduction of rotation or pressure would prevent the occurrence of infinite density. It is therefore necessary to explain what features of general relativity change this situation and make the singularity unavoidable for a wider class of initial conditions. The space-time outside a spherical distribution of matter is described by the solution of Einstein's equations discovered by Karl Schwarzschild only a few months after the publication of the general theory of relativity. Within a spherical surface, known as the horizon, no observer can remain stationary but is drawn inexorably toward the centre. This is clearly demonstrated by considering a flash of light a short time after an observer emits it. Outside the horizon, the spherical wave is displaced towards the centre but still contains the point of emission. Inside the horizon, it no longer contains that point, and in order to remain stationary there, an observer would have to overtake a wave-front, i.e. move faster than light, which is impossible. This inward dragging of light, which is impossible. This inward dragging of light and hence of course all material particles within the horizon is characteristic of a black hole and its radius is known as the Schwarzschild radius. Thus in general relativity a whole range of initial conditions which include matter with pressure, or rotation and departures from spherical symmetry which are not too large, lead to a singularity which is therefore generic.

Prof. Chandrasekhar then illustrated the importance of general relativity for the late stages in the life of a typical massive star of say twenty solar masses. Two very important features are, (i) the high degree of central condensation (with the central density as high as a billion times the mean density) and (ii) the dominance of radiation pressure. In the Newtonian theory such a star is stable against a small radial disturbance. The adiabatic exponent (ratio of fractional small pressure change to fractional density change) is greater than the critical value of 4/3. When such a star is one hundred thousand times its Schwarzschild radius, general relativity is of no importance in determining its structure but has a profound effect on its stability and in fact the star can become unstable to growing radial oscillations. The belief that black holes form in great numbers in the universe is based on such calculations.

In the latter half of his lecture, Prof. Chandrasekhar moved on to discuss the outstanding unsolved problem posed by Penrose's theorem—the classification of singularities. In the theory of functions, the classification of singularities was one of the important achievements of 19th century mathematics, and revealed that in general, a singularity must be specified by the values of various numbers which are "coded" into it. In

general relativity, the best one can do is to study specific examples. One of them is obtained when we consider spherical collapse of charged matter. Although large scale charge separations are not realisable in nature, this spacetime is of interest because it shows a singularity which is quite different from that of the Schwarzschild black hole. It is no longer inevitable that a particle entering the horizon must spiral into the centre. In fact, it is possible in principle for an observer to cross a surface known as the Cauchy horizon. At this point, he can see the entire history of the outside world, albeit in an infinitely compressed and blueshifted form. Yet another kind of singularity is found in the Kerr black hole. This describes the unique final state resulting from the collapse of a rotating body and hence describes all black holes of astronomical interest. In this case, there is a ring singularity in the equatorial plane and an observer passing through it emerges into another world.

In his concluding remarks, Prof. Chandrasekhar pointed out that conventional accounts of the big bang cosmology take too naive a view of the initial singularity. Observations of the microwave background radiation can be combined with some plausible assumptions and rigorous theorems to prove that a singularity must have existed in the past. However, we do not know its nature. It is entirely possible that the isotropy of the microwave radiation, which is a puzzle in the conventional picture, might be a consequence of the information coded into this singularity. Pending a general classification, the need is to enlarge the study of initial conditions leading to singularities. This is the motive behind some recent studies of spacetimes with colliding gravitational waves. Every such study reinforces the impression of "incredible self-consistency and beauty" of the general theory of relativity.' While there was not enough time to enter into details of his work on this problem, Prof. Chandrasekhar stated in conclusion that the sense of magic conveyed by general relativity has only been enhanced since Einstein remarked on it at the end of his first paper on the subject seventy years ago. In this sense, he shared the sentiment expressed by Einstein when asked what his reaction would have been if the eclipse experiment had failed to confirm the general theory of relativity—"I should be sorry for the dear Lord".

Honorary Fellows elected in 1984

Prof. F A Cotton, Department of Chemistry Texas A & M University, College Station, Texas, USA

Dr F H C Crick, Salk Institute for Biological Studies, San Diego, California, USA

Prof. H W Liepmann, Director, Graduate Aeronautical Laboratories, California Institute of Technology, Pasadena, California, USA

Fellows elected in 1984

S S Agarwal, K. G. Medical College, Lucknow, for his studies of DNA polymerase and those on the prevalence rates and modes of inheritance of several important populations.

P Babu, Tata Institute of Fundamental Research, Bombay, for his contributions to our understanding of the genetic organization of *Caenorhabditis elegans* and *Drosophila melanogaster.*

V Balakrishnan, Indian Institute of Technology, Madras, for his work on Regge poles, a new approach to the problem of anelasticity and generalised diffusion.

M R Das, Centre for Cellular and Molecular Biology, Hyderabad, for his contributions to tumour immunology; studies on the role of reverse transcriptase and the NMR studies and elegant magnetic resonance of biologically important intermediates.

Sulochana Gadgil, Indian Institute of Science, Bangalore, for her work on the Indian summer monsoon and analysis of the spatial variation of Indian rainfall.

V K Gaur, National Geophysical Research Institute, Hyderabad, for his contributions in the fields of geodesy, seismology and electromagnetics.

V R Gowariker, Vikram Sarabhai Space Centre, Trivandrum, for his contributions in the field of space technology with special reference to indigenous manufacture of polymers and special chemicals and propellants for rockets.

P K Malhotra, Tata Institute of Fundamental Research, Bombay, for his contributions in the area of experimental particle physics, cosmic ray studies and bubble chamber studies.

T J Pandian, Madurai Kamaraj University, Madurai, for his studies on energy transformation in fishes, crustaceans and other organisms in the laboratory as well as energy flow and trophic dynamics in aquatic and terrestrial ecosystems.

Phoolan Prasad, Indian Institute of Science, Bangalore, for his studies on the nature of interaction of radiation with fluid flows, nonlinear stability of transonic flows and kinematics of a multidimensional shock front.

S Rai Choudhury, University of Delhi, Delhi, for his contributions in field theory, particle physics and low energy nuclear physics and the low-energy theorems for Compton scattering.

A V Rama Rao, National Chemical Laboratory, Pune, for his work on the chemistry of natural products and organic synthesis.

P Ramachandra Rao, Banaras Hindu University, Varanasi, for his contributions in the area of rapid solidification of metals and amorphous and metastable alloys.

K R Shivanna, University of Delhi, Delhi for his contributions to the reproductive biology of flowering plants.

T N Shorey, Tata Institute of Fundamental Research, Bombay, for his contributions to Diophantine approximation and transcendence theory, and number theoretic function.

J S Singh, Banaras Hindu University, Varanasi, for his work in grassland and Himalayan forest ecosystems.

M S Srinivasan, Banaras Hindu University, Varanasi, for his work on micropalaeontology and the complete biostratigraphy of the Andaman-Nicobar islands.

G S R Subba Rao, Indian Institute of Science, Bangalore, for his contributions to synthetic organic chemistry and for his studies in metal reduction.

M M Taqui Khan, Central Salt and Marine Chemicals Research Institute, Bhavnagar, for his contributions to the chemistry of coordination compounds, to bio-inorganic chemistry and to homogeneous catalysis.

K S Yajnik, National Aeronautical Laboratory, Bangalore, for his contributions in the study of fluid mechanics and the theory of turbulence.

Young Associates — 1984

K N Ganesh, Centre for Cellular and Molecular Biology, Hyderabad — *Molecular biophysics*

J N Goswami, Physical Research Laboratory, Ahmedabad — *Solar system astrophysics*

B R Iyer, Raman Research Institute, Bangalore — *Relativistic astrophysics and general relativity*

E D Jemmis, University of Hyderabad, Hyderabad — *Theoretical chemistry*

R Kaul, Indian Institute of Science, Bangalore — *Field theory and particle physics*

A S Kolaskar, Centre for Cellular and Molecular Biology, Hyderabad — *Molecular biophysics*

M G Kulkarni, National Chemical Laboratory, Pune — *Polymer science and engineering*

R N Kulkarni, Central Institute of Medicinal and Aromatic Plants, Bangalore — *Plant pathology and genetics*

N Mohan Kumar, Tata Institute of Fundamental Research, Bombay — *Algebraic geometry*

T Padmanabhan, Tata Institute of Fundamental Research, Bombay — *General relativity and cosmology*

S D Prasad, National Chemical Laboratory, Pune — *Surface chemical physics*

R A Rajadhyaksha, University of Bombay, Bombay — *Catalysis and chemical engineering*

S R Shetye, National Institute of Oceanography, Goa — *Physical oceanography*

P Venkatakrishnan, Indian Institute of Astrophysics, Bangalore — *Solar astrophysics*

J S Yadav, National Chemical Laboratory, Pune — *Bio-organic chemistry*

Professor S Bhagavantam is seventy-five

Professor Suri Bhagavantam, a Foundation Fellow of the Academy, and a close associate of Professor C V Raman for over four decades, completed seventy five years on October 14, 1984. The Academy is commemorating this occasion by the publication of his collected papers.

Professor Bhagavantam was born on 14 October 1909 in Gudiwada, in the Krishna District of Andhra Pradesh. He had his early education in the City College High School of Hyderabad securing the coveted Gokhale Scholarship. He graduated in 1928 from the Nizam college affiliated then to the Madras University with first rank. Bhagavantam then joined Prof. C V Raman at the Indian Association for the Cultivation of Science at Bow Bazaar Street in Calcutta.

He commenced his research career with investigations on the optical and magnetic anisotropy in aromatic and aliphatic series of compounds. With a devotion and thoroughness which marked all his subsequent contributions, he established the relationship between the magnetic behaviour of organic crystals and their molecular form and crystal structure. Soon after the discovery of Raman Effect in 1928, Bhagavantam took up for study the Raman spectra of gases, concentrating on the interaction between rotation and vibration, the effect of pressure and the polarisation and intensity distribution in the wings accompanying the Rayleigh scattering as well as the vibrational scattering. His pioneering work on the effect of pressure on the Raman spectra of gases helped in elucidating the influence of intermolecular collisions and viscosity on the rotational structure. It also led to the development of the theory for the intensity and depolarization factors and a better understanding of the hindered rotation and oscillations of molecules in liquids and in crystals. Although Bar and Hanle had earlier studied this using circularly polarized incident light, it was Raman and Bhagavantam who considered in detail the "reversal" of circular polarization in Raman scattering for an experimental demonstration of the spin of photons.

In 1932 Bhagavantam joined the Department of Physics at Andhra University, Waltair where he remained for sixteen years, becoming successively Professor, Head of the Department of Physics and then Principal of the University Colleges. During this period, besides continuing his investigations on Raman Effect, he established an active school of experimental research in ultrasonics and developed new techniques for the measurement of elastic constants. His two books published during this period, namely "Scattering of Light and Raman Effect" and "Theory of Groups and its Applications to Physical Problems" are still among the best books that any research worker can find on these topics. He was also responsible for establishing centres of study in chemistry, marine biology, geodesy and geophysics in the Andhra University.

Although the Raman spectra of crystals and even amorphous materials had been studied, the theoretical tools for their interpretation were just being developed. It was therefore with great foresight that Prof. Bhagavantam turned his attention to the application of group theory to a study of the normal modes of oscillations in crystals with special reference to Raman scattering following the work of Wigner, Tisza, Wilson, Placzek, Rosenthal and Murphy in respect of molecules. The group theoretical methods developed by Bhagavantam and his co-workers enables one to interpret satisfactorily the splitting of the degenerate internal vibrations of complex ions, when they form crystals of lower symmetry and the splitting due to changes in environment or multiplicity of ions in the unit cell and most importantly the changes in selection rules as we go from a free ion to a crystal.

The rare combination of scientific eminence and experience in administration in Andhra University during its most difficult period naturally resulted in Prof. Bhagavantam being chosen as the first scientific liaison officer of independent India in U.K. Fortunately for science, he was released from that position soon to establish an active school of research in Physics in Hyderabad. In 1952 he became also the Vice Chancellor of Osmania University. During this period he initiated work in cosmic ray research, studies of high polymers and solid state physics and published his-third very valuable book "Crystal Symmetry and Physical Properties". His critical analysis and application of Neumann's principle to determine the independent and nonvanishing components characterizing several physical properties has had far-reaching significance. While several methods are available, as basically all of them are concerned with co-ordinate transformations corresponding to the symmetry elements of the group to the particular tensor components, Prof. Bhagavantam's method enables one to find in a simple way the number of independent components of any tensor necessary to characterize a physical property. It has helped in locating discrepancies in earlier work, a significant one being that pertaining to the classes of the cubic system, where it was shown that four stress optical coefficients are required to describe their photoelastic behaviour and not three as for the remaining three classes of the cubic system. He later extended his studies to magnetic symmetry and physical properties of crystals using complementary operation and harmonic generation and selection rules in nonlinear optics. He also took steps to rejuvenate astronomical studies and research in Hyderabad, one of the concrete results being the creation of the Rangapur observatory with its 48 inch optical telescope.

Prof. Bhagavantam enjoyed research with a dedicated zeal and it is no wonder therefore that his interests have ranged from diffraction

of light by high frequency ultrasonic waves to the elastic behaviour of matter under very high pressure and transport properties in magnetic crystals and relaxation phenomena in piezo-electrics.

From 1957 to 1962 he was the Director of the Indian Institute of Science, Bangalore and subsequently the Scientific Adviser to the Minister of Defence, Government of India. He has held many important professional positions and his career has been distinguished by laudable achievements in all his efforts. He was Chairman of the Committee for organization of scientific research in India and Vice-President of the International Union of Pure and Applied Physics. He is a past President of the Indian Geophysical Union and of the Physics Section of the Indian Science Congress.

A dedicated scientist, a fine teacher and an able administrator, he has by his example and his many-sided activities during the past fifty years made a profound impression on the academic and scientific life of the country. We warmly wish him many more years of continued activity and happiness.

Proceedings — Plant Sciences

Report by the editors

From the beginning, Section B of the Proceedings of the Academy has represented Plant and Animal Sciences. With Vol.87 (1978) a change was effected and issues containing papers in plant sciences, animal sciences and experimental biology were issued separately. Of these, the first two alternated as part I — Animal Sciences and Part II — Plant Sciences in 1979 for Vol.88. Since 1980 the Proceedings — Plant Sciences has been issued as a totally independent series. Papers in the field of cell and molecular biology now appear in the new Journal of Biosciences which the Academy started publishing in 1979.

During this period, as many as 334 papers in plant sciences have been published. These are in the following areas: plant morphology and morphogenesis, ultrastructure, bryology, pteridology, plant physiology and biochemistry, plant breeding and genetics, cytology, plant taxonomy (including chemotaxonomy and numerical taxonomy, pharmacognosy and pharmacology, wood anatomy plant histochemistry, plant pathology, mycology, bacteriology, soil microbiology, aerobiology, ecology, agriculture and forestry. The majority of papers published are in the nature of reports of original research which have often included lengthy monographic studies of exceptional merit strongly recommended by referees, besides reviews on specific topics.

Every paper received for publication is sent to at least two competent referees who may be from India or abroad. The system now being followed would eventually lead not only to identifying papers of the highest quality for publication but also identification of suitable referees who are not only critical but also prompt in the scrutiny of papers and in turning in their comments. Papers are accepted only when recommended by both referees or, when the referees recommend revision, the author revises it accordingly. In case of difference of opinion between two referees, the matter is reviewed by a member of the editorial board or by the Chairman and, in cases where a third opinion is considered necessary, the manuscript is sent to a third referee.

During the period, 840 and odd papers were received for publication. These have been reviewed by 422 referees of which 178 (about 34%) are from abroad and the rest (66%) from India. This also means that normally not more than two papers were sent to the same referee during the period. Only about 10% of the papers was accepted without revision; about 30% was accepted after revision and about 40-50% rejected.

The system of refereeing has led to considerable improvement in the quality of papers that are being published, but further efforts are still needed to ensure more speedy publication. The success of the system largely depends on the choice of suitable referees, both in regard to their competence to review manuscripts in the very diverse areas in which papers are submitted for publication and speedy review of the manuscripts and, where necessary, revision and further speedy review. What has been possible is reflected in the quality of papers now appearing in the Proceedings. This is due largely to the efforts of the members of the editorial board and the many referees in India and abroad who have given their time and expertise and helped us most generously. We are grateful to them.

Obituaries

With the passing away of **Paul Adrian Maurice Dirac** on October 20, 1984 at the age of 82, an era in physics came to an end, and one of the few surviving links with the period of the creation of quantum mechanics was lost. His is one of a handful of names that spring to mind in connection with practically every important landmark in modern physics, indeed modern science.

Dirac first trained to be an electrical engineer but then switched in 1923 to theoretical physics as a student under R H Fowler in Cambridge. The first sign of his outstanding genius appeared in his 1925 papers on "The Fundamental Equations of Quantum Mechanics". With this his reputation was made, and he became one of the founding fathers of quantum mechanics, the others being Heisenberg and Schrödinger. In the years that followed, his discoveries and theories poured out in staggering profusion; it was to a considerable extent his work that turned the period into the Golden Age of Theoretical Physics. One need only mention the quantisation of the electromagnetic field, the relativistic wave equation of the electron leading to the spin of the electron, the fine structure of hydrogen and the magnetic moment of the electron, the hole theory and the prediction of the positron, the discovery of Fermi-Dirac statistics as an aspect of the quantum mechanics of identical particles, and the theory of magnetic monopoles in quantum mechanics leading to the possibility of electric charge quantization; as instances of his daring thought and profound discoveries of that period.

Dirac's contributions to quantum mechanics are summarized in his monumental book "Principles of Quantum Mechanics" first published in 1930. Through its successive editions, it has for several generations of physicists been the most lucid and profound introduction to the foundations of the subject.

Even though the number of papers written by Dirac would appear rather small (of the order of hundred and fifty), the flow of ideas and new concepts continued unabated in the years after the Golden Age. One must mention the examination of the role of the Lagrangian in Quantum Mechanics, which ultimately led to Feynman's "path integral" approach; the classical theory of radiating electrons; the use of the indefinite metric in Hilbert space; unitary representations of the Lorentz group; the Large Numbers hypothesis; and his elaboration of generalized Hamiltonian methods to handle constrained systems. The most important use to which he put this last was Einstein's theory of gravitation.

Dirac's contributions to physics were inimitable in style and grace. He often spoke of the need for clarity in one's equations, and exemplified it best by his own work. Even matters of notation became acts of creation like the concepts of the delta function and the bra and ket vectors.

Dirac served as Lucasian Professor of Mathematics at Cambridge from 1932 to 1969. He shared the 1933 Nobel Prize for Physics with Erwin Schrödinger. He became a Fellow of the Royal Society of London very early, and among other honours one may mention the Order of Merit and the Oppenheimer Prize.

In 1937 Dirac married Margit Wigner, sister of Eugene Wigner. From 1971 until his passing away, Dirac lived and worked at Florida State University in Tallahassee as Professor of Physics.

Dirac was a profoundly modest and unassuming human being, very sparing in his words, and always generous in acknowledging his debt to others. His style and conception have been so unique and so unusual that the world of physics, which will always remember him, is never likely to see another like him.

Harshadray Ishverlal Jhala was born on 13 January 1919. He took his MBBS degree in 1943 and his MD in Pathology and Bacteriology in 1947, winning many awards during his studies. He worked for 17 years in the B. J. Medical School and Grant Medical College, Bombay as clinical pathologist and later as Professor of Pathology and Bacteriology. He was Director of the Haffkine Institute and later Director of Medical Education and Research in Maharashtra. His special interest was in microbiology, immunology and the control of communicable diseases. His extensive research work related to problems relating to a wide range of infectious diseases. He was elected a Fellow of the Academy in 1968. He was awarded Bombay Medical Union gold medals for his research in liver functions and the Navrang and J B Chatterjee gold medals.

Gopinath Kartha was born on January 26, 1927 in Kerala. He started his research work in 1949 in the Department of Physics, Indian Institute of Science, Bangalore in X-ray crystallography on the structure of barium chlorate monohydrate, in collaboration with Prof. G N Ramachandran who had just then returned from U.K. He also worked with Prof. S Ramaseshan for a short while before he moved to the newly started Department of Physics of the University of Madras with Prof. Ramachandran in 1953. After a short stay at Madras he left for USA to join Prof. David Harker's Laboratory at Roswell Park Memorial Institute, Buffalo, N. Y. Later, he became Professor and remained at Buffalo till his sudden death a few weeks ago.

Kartha did pioneering work in X-ray and protein crystallography. At Buffalo he played an important role in the ribonuclease project. He was one of the early workers to recognise the importance of anomalous dispersion in solving macromolecular structures. He used this technique with isomorphous replacement method in the structure determination of ribonuclease. His extensive studies on ribonuclease brought him international fame and eminence. He was elected a Fellow of the Academy in 1974.

Even during the short stay at Madras University, Kartha did excellent work. He studied the X-ray diffraction patterns of collagen fibers obtained from various sources. Ramachandran and Kartha proposed a triple helical model for collagen after carefully examining several diffraction patterns from collagen.

Even today their model is the most accepted structure for collagen. Kartha's theoretical contributions on direct methods and isomorphous replacement methods are also of fundamental importance in crystallography. During the past decade or so he was interested in a variety of biological structures, cyclic peptides, drugs and nucleatides.

Though he lived in the United States, he was in constant touch with his colleagues and friends at Bangalore and Madras and would spend at least a few days in these two cities every time he visited India.

Kartha was also very fond of classical music particularly Carnatic music. His love for Carnatic music could be visualised from the fact that he would drive sixty miles to attend a performance. Above all he was a very unassuming and friendly person who was comfortable in the company of scientists of any age group. He was a source of inspiration and a father figure to all young Indian crystallographers in United States. With his death we have lost a great crystallographer and a good friend.

Ganesh Sakharam Mahajani was born on 27 November 1898 and had his initial schooling in Satara. He took his B.A. degree in mathematics from the Fergusson College, Poona. He worked for a year as a Daxina Fellow in Fergusson College and was admitted as a Life Member of the famous Deccan Education Society when he was only 22. He joined St. John's College, Cambridge with a Government of India scholarship and took his mathematical tripos with a first class in 1924 becoming a wrangler. He won the Smith's prize in 1926 and the Philips Baylis Research scholarship.

He returned to India in 1926 to resume teaching in his old college, where he became Principal when he was 31 and worked in that capacity till 46, when he became Secretary of the Deccan Education Society. He was Vice-Chancellor of Delhi University (1953-57), Udaipur University (1963-71) and Poona University (1972-75). He was elected Honorary Fellow of St. John's College in 1974. He was a Foundation Fellow of the Indian Academy of Sciences. A specialist in theoretical and applied mechanics, his main scientific interests were in higher dynamics, ferromagnetism and hydrodynamics. His books on solid geometry and tensors in elementary analysis are widely used in colleges. He passed away at Pune on July 26, 1984.

Kalpathi Ramakrishna Ramanathan, one of the Foundation Fellows of the Academy and an old associate of Prof. C V Raman passed away after a brief illness on 31 December, 1984.

Ramanathan was born at Kalpathi, Palghat on 28 February 1893. He had his early education in the Government Victoria College, Palghat and the Presidency College, Madras from where he took his Bechelor's and Master's degrees in Physics. During the next seven years he worked in the Maharaja's College of Science in Trivandrum.

He joined Prof. C V Raman as a University of Madras research scholar towards the end of the year 1921, and collaborated with him in the studies of the molecular scattering of light, then in progress in Raman's laboratory in Calcutta. He published ten papers on molecular scattering of light and X-ray diffraction in liquids, gases and mixtures within a period of less than one year and was awarded the D.Sc., degree of the University of Madras for this work.

He took up a teaching appointment at Rangoon in 1922, but continued to visit Calcutta during the vacations when he began work on an intensive examination of the molecular diffraction of light by water. He detected a "weak fluorescence" in the scattered beam and attributed it to impurities in the liquid. Raman, who was not satisfied with this explanation, felt it was a characteristic of the substance, and his investigations of this 'feeble fluorescence' durring the next few years led to the discovery of the Raman Effect in 1928.

In 1925 he joined the India Meteorological Department, where he served with distinction for 23 years. His research work in the Department covered a wide range of subjects, in each of which he made basic contributions, solar and atmospheric radiation, the spectrum of the night sky, meteorological optics and acoustics, terrestrial magnetism, seismology, studies of the Indian monsoon and of storms, depressions and cyclones in the Indian seas, and the general circulation of the atmosphere over India and its neighbourhood.

His outstanding contributions were in the study of the thermal structure and movements of the upper air. His now famous diagram showing the distribution of upper air temperatures over the world, up to 25 km still retains its premier place, despite the immense amount of data gathered since on the upper atmosphere. His memoir on the general circulation of the atmosphere over India and its neighbourhood, the first clear and comprehensive study of the subject, is still considered a standard work of reference on the subject.

In 1948, he joined Physical Research Laboratory at Ahmedabad as its first Director. His research work there was mainly concerned with studies of atmospheric ozone, night airglow, ionospheric and space physics, and solar and galactic influences on the ionosphere. His work on atmospheric ozone was of such far-reaching importance that he was considered the world's leading authority on ozone.

He also took an active part in space research both in India and abroad. Of even greater importance in the long term is the interest and support he provided for the studies of interaction between the neutral and electrical atmospheres. His recognition of the thread of unity, which is a principal characteristic of space age atmospheric physics, is possibly the greatest contribution to be attributed to Ramanathan.

The world meteorological community recognised his work by awarding him the International Meteorological Organisation Prize in 1961 and electing him President of the International Association of Meteorology. He was also elected President of the International Union of Geodesy and Geophysics in 1957, and President of the International Ozone Commission for three terms starting in 1960.

In recognition of his contributions to scientific knowledge and his leadership in research, the Indian National Science Academy awarded him the Aryabhata medal. The Royal Meteorological Society elected him an Honorary Fellow in 1960. He was awarded the Padmabhushan in 1965 and Padma Vibhushan in 1976 for his service to science and the country. He was Raman Professor in 1980.

He retired from the Directorship of the Physical Research Laboratory in 1966, but continued to work as an Emeritus Professor till the end.

In spite of his erudition, his scientific achievements and the recognition that he received, the characteristic that most impressed anyone who met him was his modesty and humanity. We regret the passing of a great scientist, who by his energy and enthusiasm for research inspired many generations of students, and who has had an enduring influence on the growth and development of several scientific fields during the last seven decades, both in this country and abroad.

Nivarthi Suryanarayana Satya Murthy, Associate Director, Physics Group, Bhabha Atomic Research Centre, died on 8 October 1984 after a massive heart attack. He was only 48 years old.

During the last 27 years that he worked in BARC, he had built a very competent group in Solid State Physics with specialisation in the study of magnetic materials using polarised neutron diffraction techniques. He also established research capabilities in electron spectroscopy, Raman scattering and low temperature physics. He demonstrated his competence as an organiser in almost all the symposia in physics organised by the Department of Atomic Energy and as the General Secretary of the Indian Physics Association for two terms. For his contributions to physics, he received the Shanti Swarup Bhatnagar Award for Physical Sciences and was elected to the Fellowship of the Indian Academy of Sciences in 1975. He was also elected President, Section of Physics of the Indian Science Congress Association. He was to have delivered his presidential address in January 1985.

He was known for his wide interest in physics, particularly with respect to planning for the future. At the time of his death he had made elaborate plans for the utilisation of neutrons from the 100 MW reactor at Trombay and was also involved in the planning of accelerators, an electron synchrotron and a proton synchrotron at the Centre for Advanced Technology in Indore. He was well known for his uncompromising judgements on scientific merit.

His untimely death is a great loss personally to those of us who have known him and a loss to the physics community at large.

Bhola Nath Singh was born in 1898. He took his B.Sc., and M.Sc., degree in Botany and soon after, the D.Sc., degree from the Banaras Hindu University. He was Assistant Professor of Plant Physiology in the Department of Botany, Banaras Hindu University from 1925-30. He was the Founder-Director of the Institute of Agricultural Research at the University and served as the Kapurthala Professor of Agricultural Botany, University Professor of Plant Physiology and Irwin Professor of Agriculture during 1930-44 and after that till 1944 was Director of the Wheat-Cane Research at the Institute of Agricultural Research and from 1940 Dean of the Faculty of Technology.

His contribution towards the development of agriculture in U.P. and the country as a whole is considerable. He was responsible for the institution of agricultural research and

education at the Banaras Hindu University. His scientific work has been mainly on plant physiological studies of agricultural interest and value, the water requirements of crops, crop weather relationships, agronomy, general biology, plant pathology, genetics and cytology and physiology of parasitism.

R Srinivasan On 10 September 1984, R Srinivasan, Chairman, Department of Physics, Indian Institute of Science, Bangalore, passed away, while attending a symposium at the Indian Institute of Technology, Kanpur. This sudden end, as a result of a coronary thrombosis, terminated the promising career of a scientist who at the age of 46 had already made a mark in magnetic resonance studies, low temperature and high pressure physics.

Srinivasan was born in 1938, his father the late Dr S Ramanujam being himself a very distinguished agricultural scientist and a Fellow of the Academy. After a brilliant academic career at the Patna University, he went on an ICI scholarship to U.K. and obtained his Ph.D. in 1964 from the Birmingham University working with Professor D J E Ingram in the area of electron paramagnetic resonance. On his return, he joined the Department of Physics, Indian Institute of Science, first as a Research Officer with Professor R S Krishnan on a DAE project. His experimental skill, theoretical understanding and indefatigable energy inevitably resulted in a quick climb up the academic ladder to the rank of a full Professor in 1974. He became Chairman of the Department in 1981, making his mark felt in the administrative tasks with equal felicity.

The first major problem tackled by Srinivasan was the study of molecular motions in ferroelectric crystals, especially near the transition temperatures. He realised that ESR, NMR and eventually ENDOR techniques have to be applied intelligently and built most of the equipment needed for this task. This effort, sustained over many years, not only elucidated many of the coherent and stochastic processes but also won for him posthumously the first Ravi Shankar Award for work in the area of dielectric and ferroelectric materials. It also led him to take interest in liquid helium work in the early seventies. With characteristic zeal and effort he made the Cryogenics Facility in the Institute a leading national centre. If superconducting magnets have remained in the persistent mode for more than seven years continuously and that too in spite of power supply failures common in Bangalore, the credit must surely go to Srinivasan and his colleagues in the Cryogenics Facility. In the mid-seventies, he realised that studies at high pressures would provide a useful additional tool and developed high pressure NMR and ESR facilities, incorporating a few ingenious experimental ideas. These investigations, which were contemporary even by world standards, won for him the Shanti Swarup Bhatnagar Award for physical sciences in 1982. He had been elected a Fellow of the Academy in 1978.

His careful experiments, using equipment built in the laboratory, required team effort and Srinivasan trained many good students. He was perhaps not tolerant of performances which did not come up to his expectations. He recognised the fact that young students are attracted towards theory rather than experimental work in universities and colleges due to a dearth of experimental facilities even for demonstration experiments and laboratory classes, let alone research. He strongly felt that in condensed matter physics as in several other areas, good results can come only by a happy combination of experiment and theory. The Academy has lost a potentially great scientist, particularly in experimental physics.

Srinivasan is survived by his wife and two daughters.

Nanasaheb Ramji Tawde died on December 25, 1984 at his residence in Aurangabad. He was born on January 15, 1898 in a farming family of Malvan. He came up the hard way through school and college at Bombay and went on to King's College, London to obtain his Ph.D., under the guidance of Dr R C Johnson of the University of London in 1934. On his return to India, he joined the Bombay Educational Service and worked in various capacities and retired in 1953 as Professor and Head of the Department of Physics at the (Royal) Institute of Science, Bombay. After his retirement, he joined the Karnatak University, Dharwad where he was responsible for establishing the Department of Physics and where he served as Professor and Head of the Department till 1964, when he was appointed as Vice-Chancellor of Marathwada University, Aurangabad, which post he held with distinction till 1971. Even after he retired as Vice-Chancellor he continued to take interest in its academic activities till almost 1978.

The main thrust of Dr N R Tawde's research contributions is in the area of determinations of transition probabilities and Franck-Condon factors of diatomic molecules. He was one of the pioneers in establishing spectroscopic research in the country. He studied many diatomic molecules and the main amongst them are C_2, CH, OH, AlO, BeO, CN and N_2 which are of importance in astral and combustion studies.

In addition to being a good researcher, he had a flair for tackling problems of education and administration and contributed significantly to the cause of higher education. He was a Fellow of the Indian Academy of Sciences, and President of the Physics Section of the Science Congress in 1953. Dr Tawde was a man known for his poise and human qualities. His death is a great loss to his family, his former students and the scientific community.

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