



Patrika

January 1984 No.7 Newsletter of the Indian Academy of Sciences

Subrahmanyan Chandrasekhar— Nobel Laureate

It is a matter of great satisfaction to us that S Chandrasekhar, a Foundation Fellow of the Academy and Morton D Hull Distinguished Services Professor at the University of Chicago Laboratory for Astrophysics and Space Research, was awarded the 1983 Nobel Prize for Physics, jointly with Prof. William Fowler of the California Institute of Technology. The award was for his outstanding contributions to our knowledge of stellar structure and evolution, particularly the end point of their evolution.

Chandrasekhar was 19 years old and an undergraduate at the Presidency College, Madras, when he began to ponder over what happens when a star collapses at the end of its active life. At that time it was generally assumed that as long as heat and radiation are generated in the star's core, the resulting outward pressure holds up the star's giant gaseous envelope. When the fuel is exhausted, small stars not much more massive than the sun, collapse to form white dwarfs.

In a long voyage to England in 1930, Chandrasekhar sought to calculate what would happen in the collapse of larger stars when they burn out. Continuing his work at Cambridge, he found that if the mass of a star was more than 1.4 times that of the sun, the dense matter resulting from the collapse could not withstand the pressure and would keep on shrinking. He wrote: "Such a star cannot pass into the white-dwarf stage and one is left speculating on other possibilities".

He was barely 24 when he presented his theory at the Royal Astronomical Society meeting on 11 January 1935. The Chandrasekhar limit, which he derived

at that time, has come to be recognised over the years as one of the foundations of modern astrophysics. It led to the recognition of a state even more dense than that of a white dwarf: the neutron star, produced by the collapse of a star with two or three times the mass of the sun, accompanied by a supernova explosion. Stars more massive than that are expected to collapse into black holes.

In the year 1937, Chandrasekhar joined the University of Chicago, where he has remained since then. Shortly after arriving in Chicago, he wrote the first of his books "An introduction to the study of stellar structure". Published in 1939, it has become a classic in the field and contains a full account of his theory of white dwarfs.

Chandrasekhar turned his attention next to the motion of stars in the galaxy. He published his famous book *Principles of Stellar Dynamics* in 1942. His classic paper 'Stochastic problems in physics and astronomy' in *Reviews of Modern Physics* was published in 1943. Though not understood then, many ideas introduced by him such as the principle of dynamical friction have become crucial in our understanding of globular clusters, galaxies and indeed clusters of galaxies.

One of the key problems in astrophysics in the 1940's was the interaction of radiation with matter in the atmosphere of stars. The formulation of the fundamental equations and their solutions had to wait till Chandrasekhar turned his attention to it. His research culminated in his classical book on *Radiative Transfer* published in 1950. Recently a new branch of mathematics known as invariant imbedding has come into existence, inspired by Chandrasekhar's book of 25 years ago.

During the 1960's Chandrasekhar was engaged in a study of the stability of rotating liquid masses, though many astronomers were sceptical about the relevance of all this to real science. Once again, he published a book entitled *Ellipsoidal Figures of Equilibrium* in 1969. Today, it has become a standard text and many of the results obtained by him and his



Prof Chandrasekhar with Prof. Ramaseshan and a student

students have a bearing on the stability of fast pulsars, such as the recently discovered millisecond pulsar.

Chandrasekhar's research career started with white dwarfs; the fundamental discoveries he made 50 years earlier led inescapably to the concept of black holes and singularities. It is to this subject that he turned about 10 years ago, particularly the theory of how a rotating black hole reacts to external perturbations such as gravitational and electromagnetic waves. His latest book *The Mathematical Theory of Black Holes* published in 1983 is a truly monumental piece of work. Chandrasekhar has said that this is the hardest project he worked on and the one that gave him the greatest satisfaction.

All his books reveal his intense dedication, thoroughness, commitment to scholarship, passion for precision, the elegance of his mathematical methods and most of all his unique perspective of the subjects, which is his real motivation for research. After Chandrasekhar has written a book on a subject, it is very difficult to enter the field and do something new. As a distinguished astronomer said "Don't try to go beyond Chandrasekhar by following the same road. Your only hope is to find a different road".

Chandrasekhar was born in Lahore, India on 10 October 1911 and received his baccalaureate degree from the Madras University in 1930. He completed his Ph.D. in 1933 at Cambridge and was elected a Fellow of Trinity College. He joined the University of Chicago in 1937. In 1943 he was appointed

a full professor and Morton D Hull Distinguished Services Professor in 1952.

Chandrasekhar's work has been and continues to be honoured. He received the Bruce Gold Medal of the American Astrophysical Society of the Pacific (1952), the Gold Medal of the Royal Astronomical Society of London, perhaps the most esteemed award in astronomy (1953), the Rumford Medal of the American Academy of Arts and Sciences (1957), the Royal Medal of the Royal Society of London (1962), the Srinivasa Ramanujan Medal of the Indian National Science Academy (1962), the National Science Medal, USA (1967), the Padma Vibhushan Award (1968), the Henry Draper Medal of the National Academy of Sciences (1971), the Heineman Prize for Mathematical Physics (1974) and the Nobel Prize for Physics (1983).

On learning of the award of the Nobel Prize, Chandrasekhar is reported to have commented "I work for my own personal satisfaction on things generally outside of the scientific mainstream. Usually my work becomes appreciated only after some length of time".

To quote Chandrasekhar, "One's place in science, as posterity will duly assign, depends very largely on one's continuous exertion, at the edge of one's ability;I think one could say that a certain modesty towards understanding nature is a precondition to the continued pursuit of science".

Golden Jubilee of the Academy

1984 is the Golden Jubilee Year of the Academy. To commemorate this important event, several programmes have been planned. These essentially consist of scientific activities, which are outlined below.

1. Publications

Each of the journals of the Academy will publish a special Golden Jubilee Number during the year. These issues will include invited contributions from distinguished scientists, both in India and abroad, consisting of original articles and state-of-the-art reports on topics of current interest. While some issues are expected to appear in April 1984, the others will be published before November 1984.

2. Golden Jubilee Meeting

The 50th Annual Meeting of the Academy, has been designated the Golden Jubilee Meeting of the Academy and will be held at Bangalore from Wednesday, 7 November to Sunday, 11 November. The inaugural function will be held at the Chowdiah Memorial Hall at 4 pm on 7 November, the 96th birth anniversary of the Founder-President Professor C V Raman. The scientific meetings will be held at the Indian Institute of Science/Raman Research Institute. Three cultural programmes are planned for the Golden Jubilee week.

3. International Symposia

Four international symposia are planned during the Golden Jubilee Meeting on Supernovae and their Remnants, Computers, Atmospheric Sciences and Animal Communication. A Workshop on Supernovae and their Remnants is also planned, just before the symposium.

4. History of the Academy

It is proposed to prepare a small illustrated book, containing a historical account of the Academy, for distribution to Fellows, as a memento on the occasion of the Golden Jubilee of the Academy.

49th Annual Meeting of the Academy

At the invitation of the National Chemical Laboratory, Pune, the Academy held its 49th Annual Meeting at the National Chemical Laboratory from Monday, 7 to Wednesday, 9 November 1983.

The Meeting started with the inaugural function on the morning of Monday, 7 November in the NCL Auditorium. Dr L K Doraiswamy, Director of the NCL, in his brief welcome address, appealed to the Academy and its Fellows to take an active part in the identification of thrust areas in science and technology and to lay down guidelines for science policy in the country. After introducing the Fellows present to the audience, Prof. S Ramaseshan, President of the Academy, congratulated the 22 Young Associates selected this year and introduced them to the audience. He expressed the hope that they would interact with the Academy and revitalize it. In his presidential address on 'Recent Developments in Materials Science', he spoke of the part played by physics, chemistry and metallurgy in its development, an example of the interaction and application of different disciplines to the problem of materials needed for a variety of applications.

There were two short specialised symposia, a series of lectures on the Antarctic Expedition and ten lecture presentations by new Fellows.

The first symposium on the *Frontiers in Organic Synthesis* was held on the afternoon of 7 November 1983. The first talk was by Prof. G S R Subba Rao, of the Indian Institute of Science, Bangalore on "Some aspects of steroid synthesis." One of the main strategies in the synthesis of natural products is the construction, functionalisation and fragmentation of ring systems to obtain the desired target molecule. Dr Rao summarised in his talk the strategies of synthesis of natural products using dihydrobenzenes.

Prof. G Mehta of University of Hyderabad spoke next on 'Synthetic design of platonic hydrocarbons', followed by Prof. Sukh Dev of the Malti-Chem Research Centre, Baroda on 'Car-3-ene, a versatile resource for important industrial fine chemicals'. Several worthwhile commercially important transformations of carene, the major constituent of Indian turpentine, have been achieved during the last 10 years and extensively used in pharmaceuticals, for flavouring purposes and as important intermediates for the commercial production of important and

highly active insecticides with extremely low mammalian toxicity.

Prof. U R Ghatak of the Indian Association for the Cultivation of Science spoke on 'New stereocontrolled synthetic routes to bridged-ring and alicyclic compounds' and the *potentially important work done at IACS for the generation of basic structures of the plant hormones.*

Dr A V Rama Rao of the NCL, Pune, spoke on the 'Synthesis of biologically active compounds with a difference', the development of anticancer agents, organic synthesis and developing new plant growth regulators.

The evening lecture on 7 November was by Dr M G Deo, of the Cancer Research Institute, Bombay, on 'Anti-leprosy vaccine – the global scene'. The control strategies for leprosy are essentially aimed at containment of the microbe *M. leprae* and enhancement of the host immunity. *Since drugs are not effective, global attempts are now being made to develop a vaccine which acts by enhancing the host immunity.* He described the two vaccines used in patients and healthy high risk subjects, but due to the large incubation period of the disease, field trials can be expected to provide information on their efficiency in both immunotherapy and immunoprophylaxes, only after 5-10 years.

There were a series of lecture presentations by new Fellows on all three days of the Meeting. Dr N S Narasimhan of University of Pune spoke on 'Energy conservation – an organic chemist's attempts' and how, using aromatic lithiation reactions, a variety of heterocyclic ring systems have been developed, in simple steps and by considerably shorter routes, involving considerable energy conservation.

Dr G Rajasekaran of the University of Madras spoke on the 'Unification of the forces of nature', followed by Dr M M Johri of the Tata Institute of Fundamental Research, Bombay on the 'Development and differentiation in plants'. He described how the unique formation of new organs from the apical meristems, throughout the life span of a plant, can be explained. Dr K J Rao of the Indian Institute of Science, Bangalore spoke on 'Glass transition, a veritable clue to the nature of the glassy state', and how, considering glasses as microheterogeneous, investigations of glass transition had led to an explanation of *known experimental facts with regard to various physical quantities.*

Dr M Vijayan of the Indian Institute of Science spoke on 'Non-covalent interactions and molecular association involving biomolecules' and of the X-ray crystallographic work done by his group in determining the

3-dimensional structure of bio-molecules and elucidating the non-covalent interactions involving them.

Prof. P N Tandon of the All India Institute of Medical Sciences spoke on 'Intracranial vascular malformations'. Generally believed till very recently to be uncommon amongst Indians, pathological-anatomical studies and hospital-based incidence studies in the country have shown the incidence to be similar to those elsewhere and that saccular aneurysms constitute the commonest cause of these malformations. With the rapid advances in anaesthetic management and surgical techniques, including the use of the operating microscope, excellent results can now be achieved through surgical treatment of these lesions.

Dr R Cowsik of the Tata Institute of Fundamental Research spoke on 'Neutrinos in the universe'. The study of neutrinos in a big-bang universe yields very restrictive limits on the mass, decay properties and the number of neutrino types. After reviewing the early results and recent theoretical speculations on the properties of neutrinos, he described the paradoxical observation of dark matter on a variety of scales from clusters through binary galaxies down to dwarf spheroidals. He was followed by Dr R A Mashelkar of the National Chemical Laboratory, who spoke on the exciting new field of 'Modelling and simulation in polymer engineering', Dr N Kumar of the Indian Institute of Science who spoke on 'Diamagnetism: A surprise in theoretical physics', and Dr K Gopalan of the Physical Research Laboratory, who spoke on the 'Correlation of the tectonic belts in Kumaun Lesser Himalaya: a geochronological approach'.

The series of invited lectures on the 'Antarctic Expedition' on the morning of Tuesday, 8 November, followed by 2 films taken during the expedition 'Destination Antarctica' and 'Exploration Antarctica', provided an exciting and exhilarating glimpse of the investigations carried out during the two Indian scientific expeditions to Antarctica.

Dr S Z Qasim, Department of Ocean Development, and leader of the first expedition, spoke of the objectives of the Indian Antarctic research programme. Dealing with the theme on 'Some oceanographic features of the Antarctic Ocean', he stressed the need for Antarctic research, since only a few islands separate the Indian sub-continent from the continent of Antarctica, with its biological bounty and vast hydrocarbon and polymetallic nodule deposits. The waters within the Antarctic convergence (about 52°S) and the subtropical convergence (about 40°S), known as sub-Antarctic waters, promote processes that equalize the characterization of the three

major oceans, the Indian, Atlantic and Pacific which girdle the earth around the continent of Antarctica and the interaction between the Indian ocean and the Antarctic is of great significance for the fertility of the seas around India.

The second lecture on the 'Geological set-up around Dakshin Gangotri Antarctica and snow ice studies' was by Shri V K Raina, Geological Survey of India, and leader of the second expedition. Dakshin Gangotri, the Indian Research station in Antarctica, is located in the Schirmacher Hill range of Queen Maud Land. He presented the results of the geological mapping of an area extending about 3 km westward and 1.5 km eastward from the Dakshin Gangotri camp site and of the reconnaissance of the Wohlthat mountains around 71° 18'S and 13° 31'E. Snow accumulation and ablation studies on the ice shelf demonstrated the crucial role played by winds in the absence of any precipitation.

Shri S G Prabhu Matondkar of the National Institute of Oceanography, who took part in both the expeditions, spoke on 'Chemical and environmental studies on ice and waters'. A comparison of the atomic ratios of Antarctic waters with similar ratios from the north Indian Ocean, indicated an excess of 19% nitrate and 45% silicate in the Antarctic Ocean.

Dr C R Sreedharan of the Meteorological Office, Pune spoke on 'Meteorological aspects of Antarctica' and presented the results of meteorological observations taken during the expedition including the fierce blizzard which struck the camp for 72 hours on 18 and 19 February 1983. The lowest temperature recorded was -15°C and the highest was +8°C, with average temperatures varying between -5 and -10°C, and windspeeds about 35-40 knots with peak winds of 50-70 knots. Surface ozone varied from 30-40 μmb both over Antarctic and over the oceans and stratospheric ozone above 6-8 km reached a maximum of nearly 160 μmb at 18-20 km.

Dr A H Parulekar of National Institute of Oceanography, spoke on 'Biological investigations in Antarctic ecosystems' and presented the results of the study of the composition, distribution, abundance and productivity potentials of different ecosystems and their contribution to the continental, maritime and sub-Antarctic food web.

The evening lecture on 8 November was by Prof. B Nag of the Jadavpur University on 'Microprocessors'.

The second symposium on *Plant Tissue Culture* held on the morning of Wednesday, 9 November, was organised by Prof. H Y Mohan Ram of the University of Delhi. The

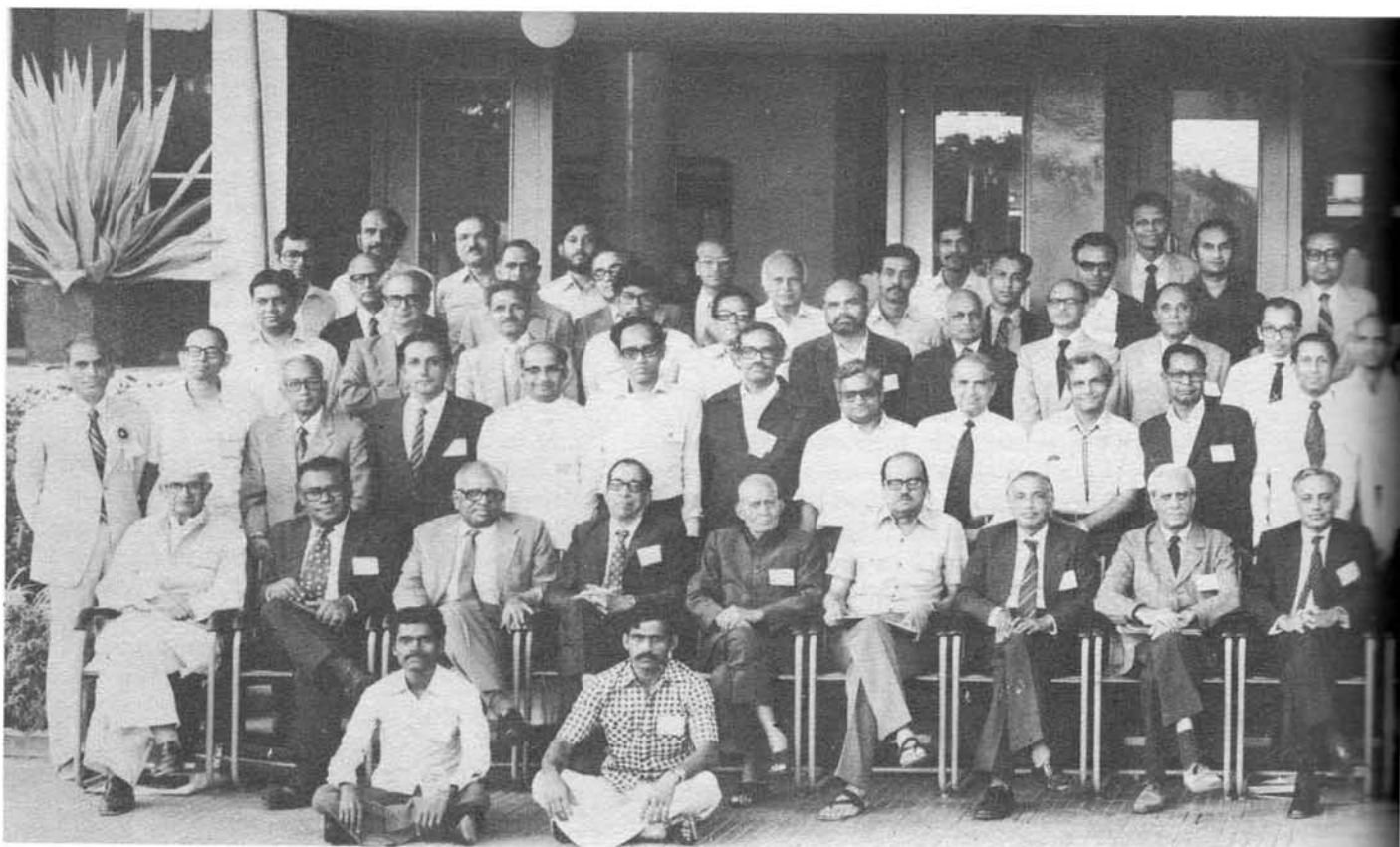
participants included Prof. A Gnanam of the Madurai-Kamaraj University, who spoke on 'Photosynthesis in cultured cells', Dr Sudhir Sopory, of the Jawaharlal Nehru University on the 'Induction of haploids: achievements, problems and possibilities', Dr S S Bhojwani of the University of Delhi, on 'Isolation and fusion of protoplasts and somatic fertilization' and Dr A C Mascarenhas, of the National Chemical Laboratory, who dealt with 'Tissue culture and micropropagation'.

The symposium highlighted the application of tissue culture in recognizing efficient photosynthetic systems, the production of haploids from pollen to augment plant hybridization and mutation programmes, novel methods of fusion of naked plant cells of selected useful species of crops which cannot be crossed through conventional plant breeding methods and micropropagation of timber, firewood and pulp yielding trees and other useful plants.

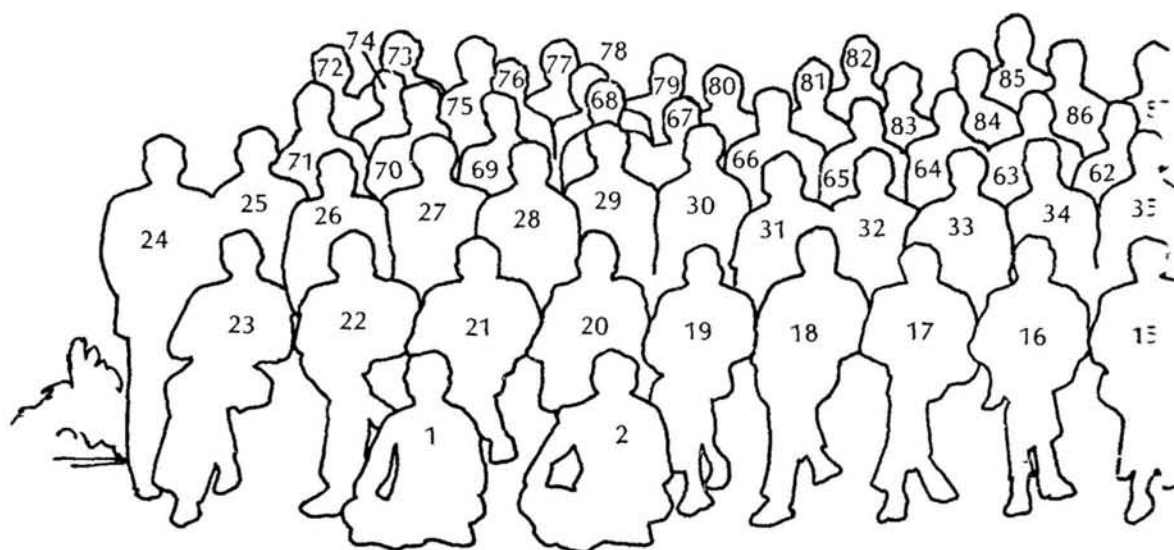
It was emphasised that through the application of the recently developed techniques of plant genetic engineering, it would be possible in the near future to boost crop production resistance to drought, cold, salt and other environmental stresses and to disease and pesticides.

The Academy is grateful to the National Chemical Laboratory, Pune and especially to the Local Organizing Committee and Dr L K Doraiswamy for the superb organization of the annual meeting, and to Prof. H Y Mohan Ram and Dr A V Rama Rao for the organization of the two specialized symposia.

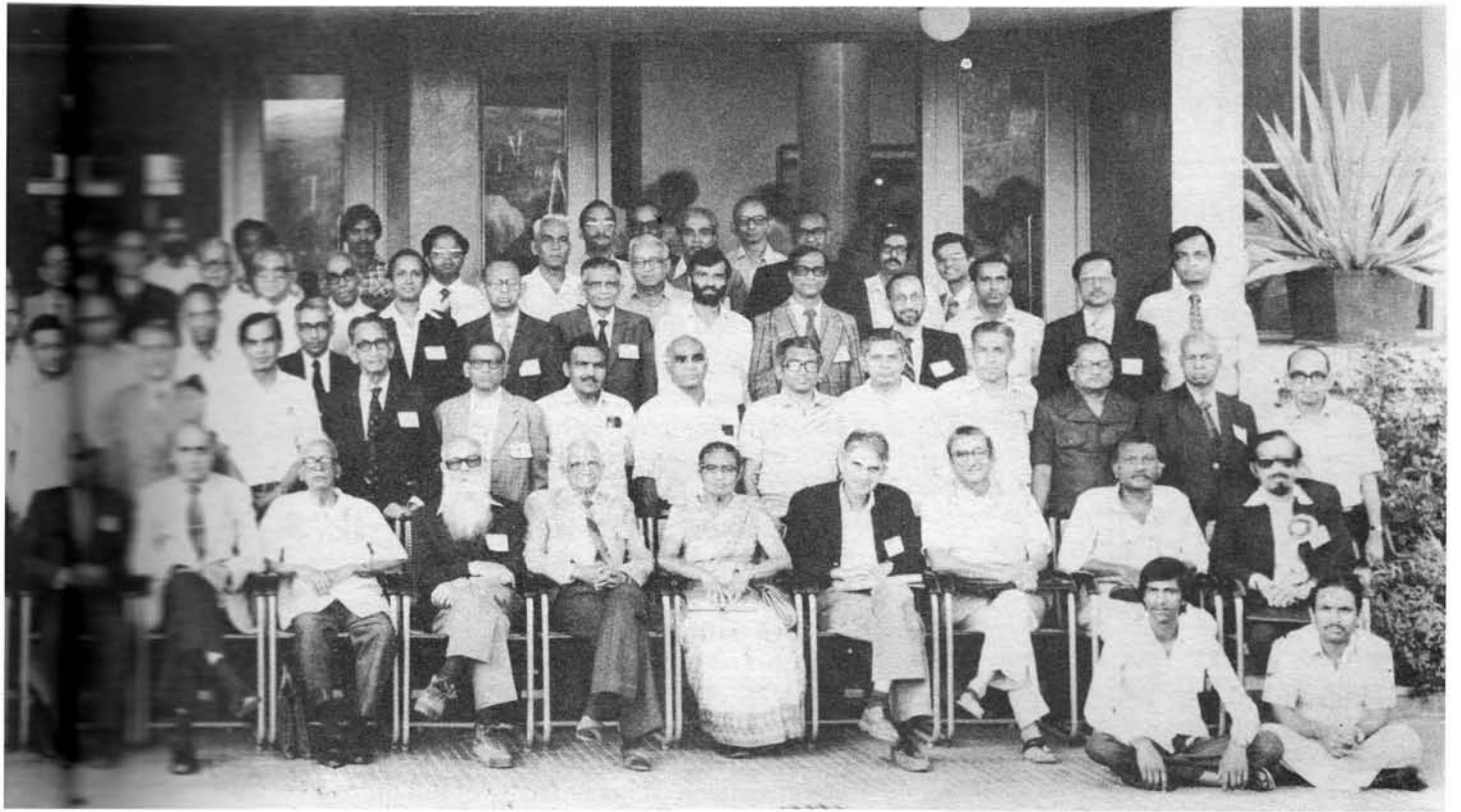
The 49th Annual Meeting was the best attended of all meetings with 114 Fellows present at Pune. The group photograph taken during the meeting is reproduced on pages 6 and 7.



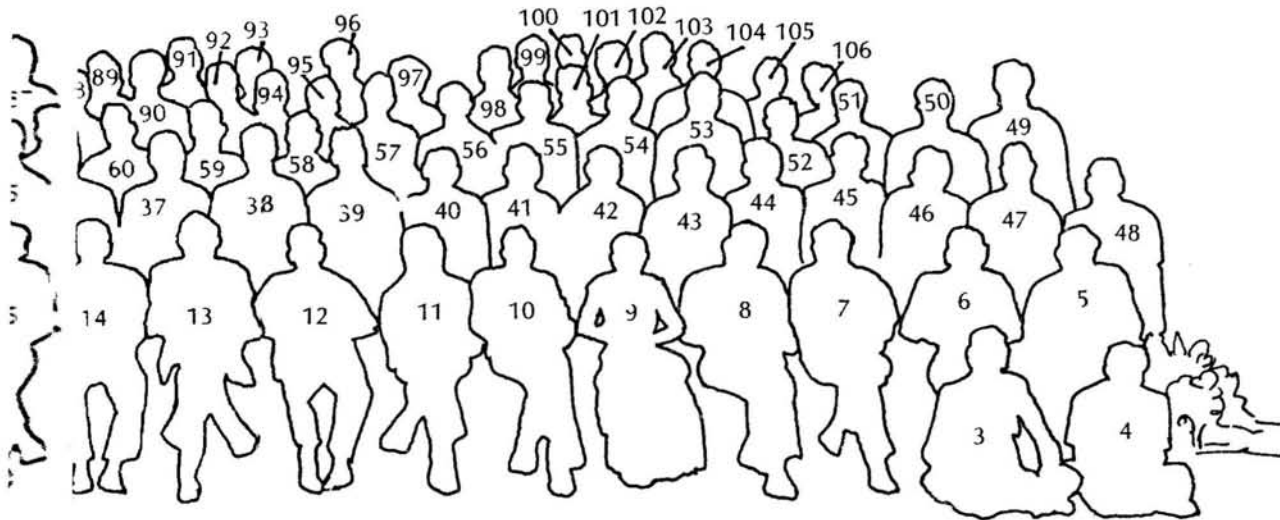
Participants at the 49th Annual Meeting of the Academy



- | | | | | |
|--------------------|---------------------|---------------------|----------------------|----|
| 1) C Vedamurthy | 13) L K Doraiswamy | 25) Madhav Gadgil | 37) D D Awasthi | 49 |
| 2) B Sethumani | 14) S Ramaseshan | 26) S Narayanaswamy | 38) M S Kanungo | 50 |
| 3) N Sheriff | 15) S Varadarajan | 27) R Cowsik | 39) V Puri | 51 |
| 4) G Madhavan | 16) S Dhawan | 28) C J Saldanha | 40) Y S Murty | 52 |
| 5) R Narasimha | 17) C V Subramanian | 29) R Srinivasan | 41) | 53 |
| 6) V Radhakrishnan | 18) B Nag | 30) M A Viswamitra | 42) P R Mahadevan | 54 |
| 7) B D Tilak | 19) S Paramasivan | 31) G S Agarwal | 43) K S Valdiya | 55 |
| 8) O Siddiqi | 20) D V Bal | 32) S S Jha | 44) V Jagannathan | 56 |
| 9) A Mani | 21) S Sriramachari | 33) R K Varma | 45) C S Vaidyanathan | 57 |
| 10) K S G Doss | 22) C N R Rao | 34) B B Biswas | 46) S Krishnan | 58 |
| 11) D K Banerjee | 23) P C Vaidya | 35) P M Mathews | 47) P R Pisharoty | 59 |
| 12) K R Ramanathan | 24) A P B Sinha | 36) D V S Jain | 48) C V K Baba | 60 |



June



D V Singh

K Nagarajan

B A Dasannacharya

K Gopalan

T B Bhat

C C Patel

M S Vardya

S Mitra

N S Narasimhan

S Swaminathan

B Venkataraman

61) S S Kalbag

62) S Rajappa

63) M R A Rao

64) P N Tandon

65) H Y Mohan Ram

66) N Kumar

67) U R Ghatak

68) H S S Sinha

69) R G Rastogi

70) B V Sreekantan

71) M M Johri

72)

73) J Thomas

74) S Y Padmanabhan

75) S K Joshi

76) M M Sharma

77) R Gadagkar

78) K K G Menon

79) K J Rao

80) C Siva Raman

99) I V Ramanuja Rao

101) N Appaji Rao

103) E S Raja Gopal

105) T N Guru Row

81) A Pati

82) T P Prabhu

83) T R Kasturi

84) M Vijayan

85) R A Mashelkar

86) G Mehta

87) A Chakravorti

88) T K Roy

89) V P Rao

90) P T Narasimhan

91) G Rajasekaran

92) B M Udgaonkar

93)

94) F Ahmad

95) R Ananthakrishnan

96)

97) N K Mehra

98) L K Ramachandran

100) J C Bhattacharyya

102) H Sharat Chandra

104) T C Anand Kumar

106) N Sathyamurthy

Honorary Fellows elected in 1983

Prof. Charles Frank, H H Wills Physics Laboratory, Royal Fort, Tyndall Avenue, Bristol, UK

Prof. G Pontecorvo, Imperial Cancer Research Fund Laboratories, Lincoln's Inn Fields, London, UK

Prof. G W Series, 4 Sandfield Road, Hedington, Oxford, UK

Fellows elected in 1983

C R Bhatia, Bhabha Atomic Research Centre, Bombay, for his contributions in biochemical genetics and mutation research on higher plants.

B M Deb, Indian Institute of Technology, Bombay, for his work in theoretical chemistry.

A P J Abdul Kalam, Defence Research and Development Laboratory, Hyderabad, for his contributions to the development of satellite launch vehicles in the country.

K K Kannan, Bhabha Atomic Research Centre, Bombay, for his work in macromolecular crystallography.

S Kedharnath, Kerala Forest Research Institute, Peechi, for his contributions in forest genetics and tree breeding in the country.

V Krishnan, Indian Institute of Science, Bangalore, for his work in co-ordination chemistry.

H S Mani, Indian Institute of Technology, Kanpur, for his contributions in theoretical particle physics.

S S Merh, M S University of Baroda, for his contributions to the study of the geology of the Lesser Himalaya and the coastal belt in Gujarat.

H S Mukunda, Indian Institute of Science, Bangalore, for his contributions to the development of hybrid rocket systems, involving the discovery and use of novel propellants.

B R Nag, Calcutta University, Calcutta, for his work in semiconductor physics, particularly on electron transport in semiconductors.

V Nanjundaiah, Tata Institute of Fundamental Research, Bombay, for his contributions to developmental and theoretical biology.

V S Narasimham, Tata Institute of Fundamental Research, Bombay, for his contributions in high energy physics and studies of deep underground cosmic radiation.

G Padmanaban, Indian Institute of Science, Bangalore, for his work in the regulation of drug metabolism in animals.

G B Parulkar, K E M Hospital, Bombay, for his contributions to the therapeutic approach of several clinical problems relating to heart diseases and improving results of open heart surgery.

Gopal Prasad, Tata Institute of Fundamental Research, Bombay, for his contributions in the area of algebraic groups.

P L Sachdev, Indian Institute of Science, Bangalore, for his contributions to the study of nonlinear waves with applications in geophysics and transonic flows.

P K Sen-Sarma, Forest Research Institute, Dehra Dun, for his work on the physiology, ecology and control of termites.

D R Sikka, Indian Institute of Tropical Meteorology, Pune, for his contributions to the understanding of many facets of the Indian summer monsoon.

G Srinivasan, Raman Research Institute, Bangalore, for his contributions in condensed matter theory and in astrophysics.

A Venkoba Rao, Institute of Psychiatry, Madurai, for his contributions in psychological medicine.

Young Associates – 1983

K R Anantharamaiah, Raman Research Institute, Bangalore — *Observational radio astronomy*

R J Azmi, Wadia Institute of Himalayan Geology, Dehra Dun — *Micropalaeontology*

M Barma, Tata Institute of Fundamental Research, Bombay — *Condensed matter physics*

R Balasubramanian, Tata Institute of Fundamental Research, Bombay — *Number theory*

T B Bhat, Defence Metallurgical Research Laboratory, Hyderabad — *Metallurgy*

D Dhar, Tata Institute of Fundamental Research, Bombay — *Statistical physics*

R Gadagkar, Indian Institute of Science, Bangalore — *Ecology and sociobiology*

S R Gadre, University of Pune, Pune — *Quantum chemistry*

- T N Guru Row, National Chemical Laboratory,
Pune — *Crystallography*
- J B Joshi, University of Bombay, Bombay —
Chemical engineering
- A K Kembhavi, Tata Institute of Fundamental
Research, Bombay — *Theoretical
astrophysics & general relativity*
- H R Krishna Murthy, Indian Institute of Science,
Bangalore — *Theory of magnetism*
- A K Lala, Indian Institute of Technology,
Bombay — *Biochemistry*
- N K Mehra, All India Institute of Medical
Sciences, New Delhi — *Clinical immunology*
- R Narayan, Raman Research Institute, Bangalore —
Crystallography and astrophysics
- K Neelakantan, Reactor Research Centre,
Kalpakkam — *Instrumentation*
- M V Nori, Tata Institute of Fundamental
Research, Bombay — *Algebra*
- L C Padhy, Tata Institute of Fundamental
Research, Bombay — *Molecular biology*
- A Pati, Indian Institute of Astrophysics,
Bangalore — *Optical astronomy*
- I V Ramanuja Rao, University of Delhi, Delhi —
Plant physiology
- V F Rodrigues, Tata Institute of Fundamental
Research, Bombay — *Genetics
and neurophysiology*
- N Sathyamurthy, Indian Institute of Technology,
Kanpur — *Theoretical chemistry*

Measuring the sizes of stars

Academy lecture given by Prof.
R Hanbury Brown, FRS., Chatterton
Astronomy Department, University of
Sydney, at Bangalore on 27 January,
1984.

Progress in astronomy, and indeed in science, depends on developing new tools and methods for observing the world around us. Accurate measurement of the apparent angular diameter of stars is an important step in understanding the nature of stars. Combining this measurement with a knowledge of the distance to the star and the flux of light received from the star, one could determine quantities like the actual flux of light radiated by unit area of the star's surface and the effective surface temperature of the star.

The first novel instrument built to make such measurements was the Michelson's stellar interferometer. Light collected by two mirrors separated over a distance is brought together to form interference fringe patterns. A measurement of the fringe visibility function leads to a determination of the apparent angular diameter of the star. The angular resolution depends on the separation D of the mirrors and the wavelength λ of the light received (resolution $\sim \lambda / D$). Michelson and his colleagues, in 1920, employed such an interferometer mounted on the 100 inch telescope at Mt. Wilson to measure successfully the angular diameter of stars. The angular diameters they could measure were restricted to greater than 0.02 arc seconds due to the limited maximum possible separation of the mirrors (20 ft). Therefore the 6 stars for which they measured the diameters were all giants or super giants.

The angular diameters of main sequence stars are of the order 10^{-4} arc seconds. To obtain such angular resolution at optical wavelengths it would be necessary to use interferometers with mirror separations greater than 100 metres. With such separations, the fringes appear washed out due to atmospheric scintillations, which introduce fluctuations in the arrival times of light at the two mirrors and turbulence, which introduces temporal and spatial fluctuations in the amplitude and phase of the wave front of light from a star.

The breakthrough came with the discovery of a novel principle by Hanbury Brown and Twiss in 1956, according to which, to obtain comparable angular resolution, it is sufficient to measure the correlation between the fluctuations in the output currents of two photoelectric detectors which detect the light

collected by the two separated mirrors. In other words, one only measures the 'interferences' of intensities of light received at the two mirrors and not of the 'waves' of light. Such a technique has the valuable property that the precision with which pathlengths have to be equalized depend on the electrical bandwidth of the fluctuations and not on the optical bandwidth, as in the Michelson's interferometer. The pathlength fluctuations due to atmospheric scintillations will have negligible influence on the accuracy of measurements. The price one pays for such an advantage is a loss in sensitivity of the intensity interferometer compared to the Michelson interferometer.

The intensity interferometer at Narrabri, Australia was built on this principle. Two large mirrors of diameter 6.7 m were mounted on rail tracks and they could be separated by a maximum distance of 188 m. The instrument was capable of resolving angles of 2×10^{-4} arc seconds and the faintest star which could be measured had a magnitude of + 2.5.

In a programme lasting about 10 years the Narrabri interferometer measured the diameters of 32 stars, some of which were in the main sequence. The results gave the first temperature scale for hot stars based entirely on measurements. Angular diameters of some stars were measured in the light of narrow spectral lines and the continuum, leading to the result that the angular size of the emission region of some stars is 5 times that of the star itself. After the instrument had made measurements of most of the available stars brighter than magnitude + 2.5, the Narrabri Observatory was closed.

The next target was to reach up to magnitudes of +9 and a resolving power of 10^{-5} arc seconds. As a first step towards this goal, an intensity interferometer was designed having a sensitivity 100 times greater than the Narrabri instrument (to go up to magnitude +7.3) and resolving power 10 times greater. This instrument would be both large and costly and would not have reached the target magnitude of +9. But a promising possibility was to modernize the Michelson's interferometer. In theory this offers a higher sensitivity and should be significantly cheaper to build. The major uncertainty is of course whether or not it is possible to overcome the effect of atmospheric scintillation and the need for high mechanical precision. But now one could use some of the modern techniques such as narrow band optical filters, photoelectric detectors, 'active optics', laser distance measuring equipment and so on. The only way to find out was to build an experimental model.

In the remainder of the talk Prof. Hanbury Brown described this experimental model of the modernized Michelson's stellar interferometer, which is being built at the

National Measurement Laboratory in Sydney, Australia and is almost complete. The instrument has many novel features. All components are mounted on reinforced concrete plinths which are anchored in a monolithic layer of sandstone, about 1 m below ground level. The coelostats, which are light collecting mirrors, are directed at a star by a computer and are corrected by a photoelectric star guiding system. The retro-reflectors which compensate the optical paths are mounted on a very precise track and move under the control of a computer and a fringe-counting laser interferometer, so that the pathlengths in the 2 arms are equalized to a few microns. Error signals from quadrant detectors are used to correct the pointing of the coelostats, so that the beams are accurately aligned with the optical axis of the telescope. The rapid angular variations of 1 to 2 arc second of the beams, due to atmospheric scintillations, is reduced to about 0.1 arc second using 'active optics'. The active mirrors are mounted on 3 piezo-electric cylinders in such a way that they can be tilted by electrical signals in any desired direction. These signals are generated on-line, using quadrant detectors and are used to compensate the atmospheric scintillation effects.

In this instrument great care is taken to see that there is minimal loss in the fringe visibility. Mechanical precision and rigidity allows path differences in the two arms to be less than 100 μm and any vibration does not change the pathlength by more than a small fraction of the wavelength of light in less than 1 millisecond. The 'active optics' corrects the tilt of the wavefront or apparent direction of incoming light. The phase variations in the light are maintained to $<10^\circ$ within the sampling interval. With all these, it is believed that it is possible to correct for a loss of fringe visibility of the order of 10 percent.

The sensitivity of the instrument with a single optical channel of 2 nanometer bandwidth will permit measurements on stars up to magnitude +7.6, falling short of the target +9. However with 10 optical channels it is possible to get up to magnitude +9. It seems that the sensitivity will be really limited by the accuracy of the angle-tracking system and perhaps for this reason the sensitivity of the interferometer may permit measurements of diameters of stars up to magnitude +8, with an accuracy of a few percent.

The pilot model of this new interferometer is almost complete and will be tested during 1984. If these tests are successful, it is intended to build a full scale instrument to carry on and extend the work which was started at Narrabri. We can now look forward to some exciting results from the new instrument.

A detailed account of this instrument will appear as an invited paper in the Academy's Journal of Astrophysics and Astronomy.

Journal of Astrophysics & Astronomy

Report by the editors

The Indian Academy of Sciences ventured into a new field of scientific publication in 1980. The tremendous strides made in astronomy in recent years, and the long publication lag and the levy of high page charges by most international journals in astronomy, had led the Academy to take this major decision. Thus the Journal of Astrophysics and Astronomy made its debut in September 1980, with a promise of a minimum publication time-lag after the acceptance of a paper and no levy of page charges. The journal began as a quarterly, the four issues in a volume appearing in March, June, September and December. With the fourth issue in December 1983 of volume 4, 1472 pages have been printed, with an average of 368 pages every year.

Altogether 167 papers were received till 31 December, 1983. Of these 115 were accepted with or without revision, 44 were rejected, and 8 are being processed. Of the 167 papers, 111 were by Indian authors, 46 from authors abroad and 10 were based on collaboration between Indian and foreign authors.

To maintain appropriate scientific standards, all papers submitted to the Journal are scrutinized by referees chosen internationally from among the most competent workers in the field. Over 200 referees have scrutinized the 167 papers received so far, each paper being generally seen by two referees. In the case of contradictory reports that cannot be resolved at the editorial office, the paper is sent to a third referee. Generally not more than two papers are sent to the same referee in a year. So far 37 referees have scrutinized two papers, and 17 three or four papers. The response of the referees has generally been very good. The time spent in refereeing a paper has been less than six weeks for half the papers received, and has rarely exceeded ten weeks.

The average time-lag between acceptance and publication has so far been about eight months, inclusive of the delays suffered by a few issues at the press. The situation has since been remedied, by resorting to computerised photo-typesetting since March 1983, reducing the printing lag to a mere 2-3 months, and the overall duration between submission and publication to about 5-6 months.

The Journal publishes papers on all aspects of astrophysics and astronomy, inclusive of

laboratory astrophysics and instrumentation. Both shorter communications as well as lengthy presentations of data are accepted as long as the content justifies it.

We welcome papers reporting the results of original research in astrophysics, astronomy and related topics.

Special publications of the Academy

In addition to the fourteen special publications described in Patrika No.2 of June 1981 and No.5 of January 1983, the following five volumes were published during the last two years.

1. Materials Processing in Space— A Workshop. Edited by S Ramaeseshan and M K Tewari. Published in 1982. Price Rs.50, US \$20, 321 pages

There has been considerable thinking in recent times on the nature of scientific and technological experiments to be carried out in space, whether the experiments should be technologically oriented, whether appreciable quantities of materials should be processed in space and whether these experiments should be oriented towards understanding phenomena, which will advance the field of materials science. But the most important argument in favour of carrying out experiments in space is that once an initial breakthrough is made, it will as usual be much easier afterwards to achieve the same result by another and simpler route.

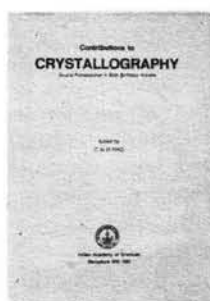
To introduce this new and exciting field to scientists and engineers in India, the Indian Institute of Science, Bangalore and the Indian Space Research Organisation, under their joint education programme, organized a Workshop on Materials and Materials Processing in Space from 24 to 29 September, 1979. To make the benefit of this Workshop available to a wider group of scientists in the country and elsewhere, many of the lectures delivered there, were published in two special issues of the Bulletin of Materials Science in 1982. These have now been collected and published in this single volume.

2. Wood Heat for Cooking Edited by K Krishna Prasad and P Verhaart. Published in 1983. Price Rs.50, US \$ 20, 255 pages

A little more than half the world's population in 1980 ate food cooked on stoves, fired for the most part by wood, and to a lesser extent by agricultural or animal waste.

Since nearly one billion people live in regions with either acute scarcity or deficit wood supply and the annual per capita energy consumption for cooking, mostly due to the inefficient use of fuel, is about 10GJ in developing countries, compared to 2.5 GJ in Western Europe, the introduction of wood stoves with superior performance should make a significant contribution to the easing of the energy supply for the rural population in developing countries.

In recognition of the magnitude of the problem the Proceedings— Engineering, Sciences devoted two issues in Volumes 5 & 6 (1982-1983) to the woodstove and these are now collected in this one volume. The papers deal with the fundamentals of woodstoves, the diversity of stoves and their performance characteristics, and modelling efforts. An earlier publication on 'Rural Technology' had demonstrated convincingly that the technologies relevant to the rural poor of the world pose interesting and challenging problems to the engineering scientist.



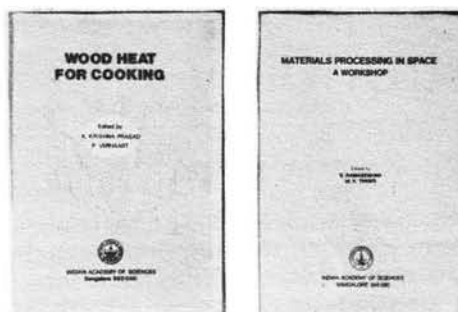
3. Contributions to Crystallography
S Ramaseshan's 60th Birthday Volume
Edited by C N R Rao
Published in 1983, Price Rs.50,
US \$ 20, 252 pages.

Prof. S Ramaseshan is known to the scientific community in India not only for his scientific contributions but for his dedicated service to the Academy. There is little doubt that much of the credit for strengthening and enlarging the publications activity of the Academy goes to him.

As Prof. Dorothy Hodgkin says in a foreword "his very varied experiences have enabled Sivaraj Ramaseshan to make still more fundamental contributions himself to the development of science in India. In his most recent work as Director of the Indian Institute of Science, he has not only created a happy and fruitful present but has laid the foundation for a future of great promise".

To mark the occasion of his attaining the age of 60, the Academy brought out this volume containing 23 papers on crystallography published in Vol.92 of the

Proceedings— Chemical Sciences. The volume was formally presented to Prof. S Ramaseshan at the 49th Annual Meeting of the Academy at Pune in November 1983.

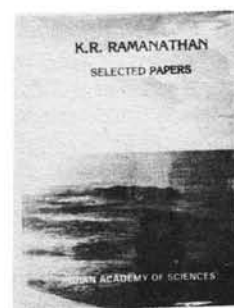


4. Selected Papers of K R Ramanathan
2 Volumes
Edited by A Mani
Published in 1983, Price Rs.300,
US \$ 65, 978 pages

These two volumes of the Selected Papers of Professor K R Ramanathan were published by the Academy on the occasion of his ninetieth birthday on 28 February 1983. A Foundation Fellow of the Academy and one who occupied its prestigious Raman Chair, he is the most distinguished meteorologist India has produced. He did his early researches with Professor Raman, but it is as a meteorologist and as one who contributed significantly to the building up of scientific meteorology that he will be remembered most.

These volumes contain his classical papers in the various fields in which he has worked during the last six decades, scattering of light, meteorology, atmospheric ozone, atmospheric physics, geophysics, aeronomy and ionospheric physics.

During his ninetieth birthday celebrations at Ahmedabad, the two volumes of his Selected Papers were formally presented to him by the President Prof. S Ramaseshan on behalf of the Academy.



Obituaries

Harish-Chandra. On 16 October 1983, Harish-Chandra, Von Neumann Professor at the Institute for Advanced Study at Princeton, New Jersey, passed away after a heart attack, while walking on the Institute's grounds near his home. He had just celebrated his 60th birthday.

Professor Harish-Chandra was born on 11 October 1923 in Kanpur. He received the M.Sc. degree from the University of Allahabad in 1943 and spent the next two years at the Indian Institute of Science, Bangalore working in quantum mechanics and particle physics, where the late Dr Homi J Bhabha collaborated with him. He joined the University of Cambridge in 1945 as a graduate student of Professor Dirac and received his Ph.D. in mathematical physics from Cambridge in 1947. At the Institute for Advanced Study at Princeton, where Harish-Chandra was offered a temporary membership soon after, he changed over completely to research in pure mathematics. His main interest was the study of infinite dimensional representations and his work centred around the study of semi-simple Lie groups and Lie algebras. They first arose in quantum mechanics during the 1930's when it was necessary to analyze the effect of symmetries on the motions of particles and waves. For these representations Harish-Chandra created a theory with implications for many domains from geometry to number theory.

After a stay of three years at Princeton, Harish-Chandra moved to Harvard on a Jewett Fellowship. He stayed there for two years and came to India as a Visiting Professor at the Tata Institute of Fundamental Research, Bombay during 1952-53. It was then that he married Lalitha Kale, the only daughter of Dr G T and Mrs H Kale, of the Indian Institute of Science, Bangalore. From 1953 till 1963 he was Professor at the Columbia University in New York. His outstanding work on semi-simple Lie groups deservedly obtained for him a permanent Professorship at the Institute of Advanced Study in 1967, where he was the IBM Von Neumann Professor from 1970 till his death in 1983.

Harish-Chandra was Guggenheim Fellow from 1957 to 1958 and a Sloan Fellow from 1961 to 1963. He was elected Fellow of the Indian Academy of Sciences in 1975 and of the Indian National Science Academy in 1975. He was elected Fellow of the Royal Society in 1973, the first pure mathematician from India, after the late Srinivasa Ramanujan to be elected to that Society, and a Fellow of the National Academy of Sciences, USA in 1981. He was an Honorary Fellow of the Tata Institute of Fundamental Research, Bombay and was

awarded honorary doctorates by Delhi University in 1973 and Yale University in 1981.

Harish-Chandra was awarded the Cole Prize of the American Mathematical Society and the Srinivasa Ramanujan Medal of the Indian National Science Academy. He is the only Indian mathematician, other than Srinivasa Ramanujan, whose collected works have been published.

Harish-Chandra despite his greatness and his achievements, was a very friendly and extremely lovable person. His was a life totally dedicated to his calling but he would always take time off from his work to meet his friends and enjoy a few moments of relaxation. His extraordinary achievements were made possible by the invaluable support of his charming wife and his two daughters, who have undoubtedly provided him much happiness and encouragement.

A great human being and a great mathematician, his passing away is an irredeemable loss to his family, to the mathematical community in the world and to all his friends and colleagues who loved, admired and respected him.

In the passing away of **E K Janaki Ammal**, a Foundation Fellow of the Academy, the Academy and botanical science have lost a distinguished and totally devoted scientist. Janaki, as she was known to most of her age group and as Dr Ammal to many younger to her, was in the forefront of botanical science in general and cytology in particular, throughout her very active and vigorous scientific career.

Born in 1897 in Kerala, Edavalesh Kakkat Janaki Ammal graduated from the Madras University with a degree in botany and later obtained the degree of Doctor of Science from the University of Michigan in 1931. She worked as sugarcane geneticist at the Sugarcane Breeding Station at Coimbatore during 1934-39, went abroad to work as Assistant Cytogeneticist at the John Innes Horticulture Institute, Oxford and Cytologist to the Royal Horticultural Society in Britain. She spent the war years in Britain and during the period 1939-52 devoted herself to cytogenetic work. The *Chromosome Atlas of Cultivated Plants*, which she co-authored with Professor C D Darlington, is one of her most significant and well-known contributions. During 1952-54, at the invitation of the Government of India, she was associated with the work of reorganisation of the Botanical Survey of India. Indeed, with this assignment she was now back in India. She was appointed Director of the Central Botanical Laboratory at Allahabad in 1954, a position she held till 1959. Still very active, she continued for another decade as Officer on Special Duty and Emeritus Scientist working at the Regional Research Laboratory,

Jorhat and also at Srinagar under the auspices of the Council of Scientific and Industrial Research. For a short period, she was also a Visiting Professor at the Bhabha Atomic Research Centre, Bombay. From 1971, till her death she worked at the Centre of Advanced Study in Botany in the University of Madras and was supported in her work by projects granted to her by the University Grants Commission and the Department of Science and Technology.

During this period she not only guided the research of several students for their Ph.D. degree but made many useful collection trips to the forests of the West Coast. She collected plants of medicinal and economic value and carried out valuable studies on the cytology of several plant taxa. Her studies in the field of ethnobotany, particularly the use of plants by tribals in Kerala, which she undertook during her last years, are of great value. She was awarded the LL.D. degree by the University of Michigan in 1955 and honoured with Padma Shri by the Government of India in 1977.

P N Ganapati passed away after a brief illness, on 5 January 1984 at Bombay.

Born on 15 July 1910 in a village near Palghat, Professor Ganapati had his early education in Ernakulam and in Madras, where he graduated from the Presidency College in 1932. He took his Master's degree in 1934 and the D.Sc. degree in 1942 from the University of Madras. After a brief assignment in the Central Marine Fisheries Research Institute, Mandapam, he spent two years at the Molteno Institute of Parasitology, Cambridge. After his return in 1949, he joined the Zoological Laboratories at the Andhra University, Waltair, and became the Head of the Department, succeeding the late Prof. R. Gopala Iyer, who was also his teacher. He retired in 1970 but continued as an Emeritus Professor till his death. Apart from his keen interest in parasitology, he promoted active research in marine biology, and organized systematic oceanographic measurements, particularly during the International Indian Ocean Expedition (1958-63).

He is survived by his wife, two sons and two daughters.

Winston E Kock died in Ann Arbor, Michigan, on 25 November 1982 at the age of 72. He was a prolific inventor with over 235 US and foreign patents.

Kock received his formal schooling at the University of Cincinnati. In the several years following, he obtained a Ph.D. in physics at the University of Berlin, was admitted to the Institute of Advanced Study at Princeton, and studied at the Indian Institute of Science, Bangalore. His post-doctoral studies, sponsored by Baldwin

Piano Co., at the Indian Institute of Science, were on an analysis of the piano string considered as an electrical transmission line. In 1936 he became a research engineer at Baldwin, where his creative ideas led to the invention of the formant electronic organ.

He joined the Bell Laboratories in New Jersey, where he assisted in the development of fire control radars for the Navy. Following the war, his inventions of various microwave lens antennae found use in early Bell System microwave radio relays for telephone and TV transmission, including the first transcontinental telecast. As Director of Acoustics Research, he will be remembered for his papers and fascinating demonstrations on microwave/sound analogies, using his inventions of acoustic lenses, prisms, waveguides and also devices for the production and manipulation of transverse mode (polarized) sound waves. As Director of Audio and Video Research, he headed studies on band compression for voice transmission and initiated development of a picture-phone for use over telephone lines. As Director of the Research Laboratories at Southfield, Michigan, he was involved in areas such as side-looking synthetic aperture radar, lasers and holography. Later, in 1964 he helped establish a NASA Engineering Research Centre in Cambridge, Massachusetts, guiding work on space and aeronautical electronics. He was an Honorary Fellow of the Indian Institute of Science and an Honorary Fellow of the Indian Academy of Sciences.

Among his many books in the fields of sound waves, radar, lasers and holography, is one entitled, "The Creative Engineer – The Art of Inventing", an apt description of the man himself and his talents. He leaves his wife, two sons and a daughter.

In the death of **Brahm Prakash** on 3 January 1984, the Indian scientific community lost an eminent metallurgist and scientific administrator. Dr. Prakash's contributions ranged over a wide field – metallurgical education, development of nuclear materials for the indigenous nuclear energy programme and nurture of the space programme in its formative years. He has left an indelible mark in each one of the institutions he served and his work is a model that will continue to inspire generations of scientists to come.

Brahm Prakash was born on 21 August 1912 at Lahore and obtained his B.Sc. (Hons.) in 1932, M.Sc. in 1934 and Ph.D. in Physical Chemistry in 1942 from the Punjab University. Subsequently he obtained his Sc. D. in Metallurgy from the Massachusetts Institute of Technology, USA, in 1949. After returning to India he served at the Indian Institute of Science, Bangalore, from 1951-1957, at the

Volume 1 (1980)

Comoving frame calculations of spectral lines formed in rapidly expanding media with the partial frequency redistribution function for zero natural line width; *A Periaiah*. Lines formed in rotating and expanding atmospheres; *A Periaiah*. Pulsar activity and the morphology of supernova remnants; *V Radhakrishnan and G Srinivasan*. The role of general relativity in astronomy: retrospect and prospect; *S Chandrasekhar*. Evidence for a large population of shocked interstellar clouds; *V Radhakrishnan and G Srinivasan*. A search for OB stars in supernova remnants; *S van den Bergh*. XX Cam—the inactive R CrB star; *N Kameswara Rao, N M Ashok and P V Kulkarni*. A dispersion relation for open spiral galaxies; *G Contopoulos*. Comments on the source function equality in (Zeeman)-multiplets; *L G Stenholm and R Wehrse*. An iterative simultaneous solution of the equations of statistical equilibrium and radiative transfer in the comoving frame; *A Periaiah*. Effects of high velocities on photoionization lines; *A Periaiah and G Raghunath*. The structure of integrated pulse profiles; *M Vivekanand and V Radhakrishnan*. Central regions of Sersic-Pastoriza galaxies; a photographic study; *T P Prabhu*. Supernovae and the A_p phenomenon; *R Rajamohan and A K Pati*. Convective instability in the solar envelope; *D Narasimha, S K Pandey and S M Chitre*. NGC 4650 A: A nearly edge-on ring galaxy?; *S Laustsen and R M West*. No detectable supernova remnant near the pulsar PSR 1930+ 22; *W M Goss and D Morris*. A new spectroscopic facility at millimetre wavelengths; *A Baudry, J Brilliet, J M Desbats, J Lacroix, G Montignac, P Encrenaz, R Lucas, G Beaudin, P Dierich, A Germont, P Landry and G Rerat*.

Volume 2 (1981)

General relativistic analysis of structure and stability of charged fluid disks around compact objects; *A R Prasanna and D K Chakraborty*. An analysis of the orbital periods of some eclipsing binaries suspected to be in the pre-main sequence contraction phase of evolution; *T Panchatsaram and K D Abhyankar*. Extragalactic sources with one-sided radio structure; *V K Kapahi*. Pulsating radio emission at decametre wavelengths from the sun; *Ch. V Sastry, V Krishan and K R Subramanian*. Luminosity- $H\alpha$ velocity width relation for spirals; *N Visvanathan*. Photon escape probabilities in expanding atmospheres; *A Periaiah, K E Rangarajan and D Mohan Rao*. On the relationship between pulsars and supernova remnants; *R K Kochhar*. Intrinsic properties of carbon stars. I. Effective temperature scale of N-type carbon stars; *T Tsuji*. A spectroscopic orbit for 26 comae; *R F Griffin*. A model of the Algol type close binary TT Hydrae; *A G Kulkarni and K D Abhyankar*. Time-dependent interaction of granules with magnetic flux tubes; *P Venkatakshnan and S S Hasan*. Photographic spectrophotometry of selected bright B and Be stars; *E M Hendry and J D R Bahng*. Anomalous giants in magellanic cloud clusters; *P W Hodge*. How high can a mountain be?; *P A G Scheuer*. Current rate of nucleosynthesis and its implications; *D C V Mallik*. Interstellar masers: the influence of the geometrical shape on the radiation properties; *Eric Bettwieser*. Long term variations in solar flare activity; *J N Goswami, R Jha and D Lal*. Mass segregation in globular clusters; *K K Scaria and M K V Bappu*. Effects of redistribution with dipole

scattering on line source functions; *A Periaiah and K E Rangarajan*. Intrinsic properties of carbon stars. II. Spectra, colours and HR diagram of cool carbon stars; *T Tsuji*. Optical depth effects on the formation of spectral lines in rotating and expanding spherical atmospheres; *A Periaiah, G Raghunath and K N Nagendra*. On the MgH oscillator strengths; *K Sinha*. A Doppler theory of quasars; *J V Narlikar and M G Edmunds*. A spectroscopic orbit for HD 115968; *R F Griffin*. A new look at pulsar statistics—birthrate and evidence for injection; *M Vivekanand and R Narayan*. The structure of the Cygnus Loop at 34.5 MHz; *Ch. V Sastry, K S Dwarakanath and R K Shevgaonkar*. Changes in sizes and shapes of spherical galaxies in head-on collisions; *F Ahmed and S M Alladin*. The two components in the distribution of sunspot groups with respect to their maximum areas; *M H Gokhale and K R Sivaraman*. Plasma heating in a sheared magnetic field; *V Krishan*. Rotation and luminosity variations in post-main sequence stars; *P J Wiita*. Equilibrium configuration of the magnetosphere of a star loaded with accreted magnetized mass; *Y Uchida and B C Low*. Structure and stability of rotating fluid disks around massive objects. I. Newtonian formulation; *D K Chakraborty and A R Prasanna*.

Volume 3 (1982)

Spectroscopic binaries near the north galactic pole. Paper 3: HD 105341; *R F Griffin*. Braided rings of Saturn—its topology; *R Pratap*. On Franck-Condon factors and intensity distributions in some band systems of I_2 , NS and PS molecules; *K Raghuvver and N A Narasimham*. Spot activity in the RS CVn binary HR 1099; *M V Mekkaden, A V Ravendran and S Mohin*. A study of the H-Alpha line in late G and K supergiants; *S V Mallik*. Kerr-Newman metric in cosmological background; *L K Patel and H B Trivedi*. Doppler shift measurements on the green coronal line—evidence for large scale macroscopic mass motion; *N N Desai, T Chandrasekhar and P D Angeji*. Ultraviolet observations of the hydrogen deficient variable star MV Sagittarii; *N K Rao and K Nandy*. Analysis of the UVB light curves of TT Hya by Kopal's frequency domain method; *J Koul and K D Abhyankar*. Spectroscopic binaries near the north galactic pole, Paper 4: HD 120803; *R F Griffin*. Spectroscopic binaries near the north galactic pole. Paper 5: HD 117064; *R F Griffin*. The Jeans problem for a thin galaxy in steady state; *R Whitley*. Global stability of disk-bulge systems: spiral structure of disk galaxies; *A Ambastha and R K Varma*. Spectrophotometric observations of a peculiar nitrogen-rich planetary nebula NGC 2440; *R Louise*. Time structure of solar decametre type III radio bursts; *G Thejappa and Ch. V Sastry*. Compact radio cores and the relation between the radio and optical axes of elliptical galaxies; *V K Kapahi and D J Saikia*. VLA observations of hot spots in high luminosity radio sources; *R T Schilizzi, V K Kapahi and S G Neff*. The identification of CTA 21; *D A Allen, A E Wright and J G Ables*. Structure and stability of rotating fluid disks around massive objects. II. General relativistic formulation; *D K Chakraborty and A R Prasanna*. Observations of the supernova remnants HB 9 and IC 443 at 34.5 MHz; *K S Dwarakanath, R K Shevgaonkar and Ch V Sastry*. The eclipsing binary V836 Cygni: photometric evidence for an early evolutionary status; *R A Breinhorst and H W Duerbeck*. The spectroscopic orbit of the short period eclipsing binary V836 Cygni; *H W Duerbeck and J D Schumann*. On selection effects in pulsar searches; *M Vivekanand, R Narayan and V Radhakrishnan*. Eclipse observations of coronal lines. I. (Fe X) λ 6374 Å profiles at

the eclipse of 16 February 1980; *J Singh, M K V Bappu and A K Saxena*. HD 147010: The Ap star in the reflection nebula vdB 102 in upper Scorpius region; *N K Rao and R Rajamohan*. Chromospheric activity of late-type giants and supergiants: reappearance of dynamo activity in the interior due to the spin-up of the core in evolution; *Y Uchida and M K V Bappu*. On the Balmer progression in the expanding shell of Pleione; *A Peraiah*. Intensity and polarisation line profiles in a semi-infinite Rayleigh-scattering planetary atmosphere. I. integrated flux; *R K Bhatia and K D Abhyankar*. Exact relativistic model for a superdense star; *P C Vaidya and R Tikekar*. Further observations of radio sources from the BG survey. II. Mainly extragalactic; *F Mantovani, M Nanni, C J Salter and P Tomasi*. A new look at the birthrate of supernova remnants; *G Srinivasan and K S Dwarakanath*. Posterior probability of the deceleration parameter q_0 from quasars provided with a luminosity indicator; *T Kiang and F-h Cheng*. Morphology of H-Alpha filaments and filament channel systems; *V I Makarov, M N Stoyanova and K R Sivaraman*. Spectroscopic binaries near the north galactic pole. Paper 6: BD 33° 2206; *R F Griffin*. On a nonlinear and Lorentz-invariant version of Newtonian gravitation; *J J Rawal and J V Narlikar*. Interstellar electron density; *M Vivekanand and R Narayan*. The role of proton cyclotron emission near accreting magnetic neutron stars; *K M V Apparao, S M Chitre, and M J Rees*. Maximum entropy image reconstruction—a practical non-information-theoretic approach; *R Nityananda and R Narayan*. Near-infrared observations of some of the IRC sources; *K V K Iyengar, F Strafella, D Lorenzetti and C B Cosmovici*. Relativistic beaming in the central components of double radio quasars; *V K Kapahi and D J Sarkia*. Reflection effect in close binaries. I. Distribution of radiation from a point source; *A Peraiah*.

J J Barnard. Relative abundances of cosmic ray nuclei from neon to iron over Fort Churchill; *P K Das and T D Goswami*. The dependence of brightness distribution on the inclination of galaxies; *V M Arreguine and J L Sersic*. Observations and interpretation of solar decametric absorption bursts; *N Gopalswamy, G Thejappa and Ch V Sastry*. On the shape of elliptical galaxies; *J L Sersic and V M Arreguine*. Membership of stars in faint galactic open clusters; *G S D Babu*. VLA observations of 'compact' sources in CTB 80; *T Velusamy and M R Kundu*. Production of dayside ionosphere of Mars; *R N Singh and R Prasad*. Modelling of seeing effects in extragalactic astronomy and cosmology; *S Djorgovski*. Multifrequency spectra of solar brightness temperature derived from eclipse observations; *S K Alurkar, R V Bhonsle, S S Degaonkar, O P N Calla and G Raju*. A Bianchi type I tilted universe; *G Mukherjee*. Neutrino degeneracy and the primordial abundance of helium and deuterium; *P Khare and B B Deo*.

Volume 4 (1983)

Scanner observations of the classical Cepheids RT Aur and T Vul; *B S Rautela and S C Joshi*. Reflection effect in close binaries. II. Distribution of emergent radiation from the irradiated component along the line of sight; *A Peraiah*. Spectroscopic binaries near the north galactic pole. Paper 7: HD 107742; *R F Griffin*. Spectroscopic binaries near the north galactic pole. paper 8: HD 121844; *R F Griffin*. Intensity and polarization line profiles in a semi-infinite Rayleigh-scattering planetary atmosphere. II. Variation of equivalent width over the disk; *R K Bhatia and K D Abhyankar*. Intensity and polarization line profiles in a semi-infinite Rayleigh-scattering planetary atmosphere. III. Variations of polarization profiles and the Stokes Parameter Q over the disk; *R K Bhatia and K D Abhyankar*. Diffuse radio emission from the Coma cluster of galaxies at decametre wavelengths; *Ch V Sastry and R K Shevgaonkar*. Astrophysical molecules of AlH and CaH: RKR potential and dissociation energies; *B Narasimhamurthy and N Rajamanickam*. Ultraviolet variability of HD 62001—The central star of the missing nebula V-V 1-7; *N K Rao and D P Gilra*. Evidence for a temperature maximum in the corona from λ 5303 Å linewidth observations: eclipse of 1980 February 16; *J N Desai and T Chandrasekhar*. Abundance analysis of selected Cepheids and the galactic distribution of metallicity; *S Gindhar*. The large-scale distributions of quasars identified with strong radio sources at 5 GHz; *P Shastri and Gopal-Krishna*. Astrophysical properties of red giants in three open clusters older than the Hyades; *J J Claria and E Lapasset*. Nonlinear development of convective instability within slender flux tubes. I. Adiabatic flow; *P Venkatakrishnan*. Reflection effect in close binaries. III. Distribution of radiation incident from an extended source; *A Peraiah*. The distortion wave on the light curve of the RS CVn Binary UV Piscium; *P V Rao and M B K Sarma*. Spectroscopic binaries near the north galactic pole. Paper 9: HD 116378; *R F Griffin*. Reflection effect in close binaries. IV. Limb darkening of the reflected radiation incident from an extended surface of the secondary; *A Peraiah and M S Rao*. Reflection effect in close binaries. V. Effects of reflection on spectral line formation; *A Peraiah and M S Rao*. Are pulsars externally triggered?; *J Arons and*

Bhabha Atomic Research Centre, Bombay, from 1957-1972 and at the Vikram Sarabhai Space Centre, Trivandrum from 1972-1982. While the tasks at these institutions called for different skills, they all posed challenges of a high order. Dr. Prakash discharged them with distinction and has left a rich legacy of scientific and administrative leadership.

At the Indian Institute of Science, Bangalore Prof. Prakash was the first Indian Head of the Department of Metallurgy. He laid the foundations for an excellent centre for metallurgical education and research in the country. Interesting investigations were carried out at this time on the beneficiation of lead-zinc ore from Zawar mining, bricqueting of beryl dust, separation of hafnium from zirconium by vapour phase dechlorination, electro and pyrometallurgical production of zirconium.

At the Bhabha Atomic Research Centre Dr. Prakash served as the Director of the Metallurgy group. Under his leadership Indian metallurgists developed the knowhow for the extraction and fabrication of a variety of reactive, refractory and radio-active metals. Special mention may be made of the establishment of the radio-metallurgical laboratory for the handling of plutonium, with provision for plutonium development, large scale production of nuclear grade zirconium sponge, metallic fuel element fabrication at the Nuclear Fuel Fabrication Facility at Trombay and uranium oxide fuel development at the Nuclear Fuel Complex at Hyderabad.

At Vikram Sarabhai Space Centre, Dr. Prakash welded together a variety of task forces to set up a Space Science and Technology Centre. His guidance led to the development of the Aryabhata satellite and the launch vehicle SLV-3. A remarkable number of skills were mastered by Indian technologists in the areas of metallurgy, polymer, composite materials and propellants in making successful forays into space.

Mention also must be made of his fruitful association with Mishra Dhatu Nigam at Hyderabad where strategic alloys for high temperature applications are manufactured. India is one of the few countries possessing this capability with enormous implications for our defence.

Dr. Prakash ushered in an era of advanced materials and processes in India. A man of few words, he was known for the total dedication and commitment he brought to every task he was involved in. A grateful nation honoured him in many ways: Padma Shri (1961), Bhatnagar Memorial Award (1963), Padma Bhushan (1968), Presidentship of the Indian Institute of Metals (1972), Vasvik Research Award (1976), Bhatnagar Medal of the Indian National Science Academy (1979) and the Balco Medal of the Indian Institute of Metals

(1980). In carrying forward the work he has initiated with the tradition he has established, the Indian metals and materials community will be paying him a richly deserved tribute.

Dr. Prakash leaves behind his wife, Mrs. Rajeshwari Prakash, an educationist, a son and two daughters.

Harish-Chandra – A tribute

While it is fitting that the Indian Academy of Sciences should make mention of the passing away of the Indian born physicist-mathematician, Harish-Chandra, the death of such a great scientist demands much more than a slight notice. It is an occasion for much introspection and self examination on the part of the entire community of Indian scientists. After Srinivasa Ramanujan, he was, undoubtedly, the greatest Indian mathematician. In the words of his foremost disciple V S Varadarajan 'history will be astonished at the work he did and will say that he got more out of his one life than most can do with two lifetimes. He joins the immortals of science'. The four volumes of his collected works now being issued by Springer have as much of the mathematician as a great one can leave behind him.

My own encounter with him was extremely brief. During the years 1963-64, I was learning the theory of representations of Lie groups and Lie algebras and the mathematical foundations of quantum mechanics from Varadarajan and Ranga Rao at the Indian Statistical Institute, Calcutta. On the advice of Varadarajan I began studying Harish-Chandra's famous paper 'On some applications of the universal enveloping algebra of a semi-simple Lie algebra' in the Transactions of the American Mathematical Society, 1953. This made a deep impression on me by its cumulative force resulting from a thorough marshalling of facts without a semblance of any seductive literary appearance. It was during this period that Harish-Chandra visited the Indian Statistical Institute and Bose Institute for a few days. I had the opportunity of listening to him speaking on his latest work on invariant eigen-distributions, distribution characters and Plancherel formula for semi-simple Lie groups. Later in 1966, I had the pleasure of being present in the Moscow University lecture hall, when he delivered his invited address on the same theme, during the International Congress of Mathematicians. To this day I cherish the memory of these two delightful lectures of the Master.

For Harish-Chandra the subject of infinite

dimensional representations of semi-simple Lie groups and Lie algebras was a passion ever since he began investigating them at the suggestion of Dirac in the late 1940's. In the words of Varadarajan 'he has erected since then, almost single handedly, a monumental theory of harmonic analysis on reductive groups and their homogeneous spaces. His work is a profound synthesis of algebra, geometry and analysis. The great force and continued resonance of his ideas have inspired a generation of mathematicians. The singlemindedness and courage with which he pursued his goals, the beauty of his results, the power and originality of his methods, and the ultimate simplicity of his philosophy as well as the conviction that sustains it, compel our admiration. There can be no doubt that his achievement is one of the greatest in mathematics in our time.'

Like Riemann 'he was one of those retiring men of learning who allow their profound thoughts to mature slowly in the seclusion of their study'. All along his motto seemed to be तस्मिन्वदन्तः तदुपासितव्यम् . There was never a question of his going out in search of students. He was like 'a lotus that seeks not the wandering bee'.

It is rather sad that in the vast country of his origin there is just one place, namely the School of Mathematics at the Tata Institute of Fundamental Research, Bombay, where an aspiring young mathematician can hope to get a glimpse of the profound developments in the great theme of Lie groups and their representations, which received such a tremendous flowering from the hands of Cartan, Weyl, Gelfand and Harish-Chandra.

K R Parthasarathy