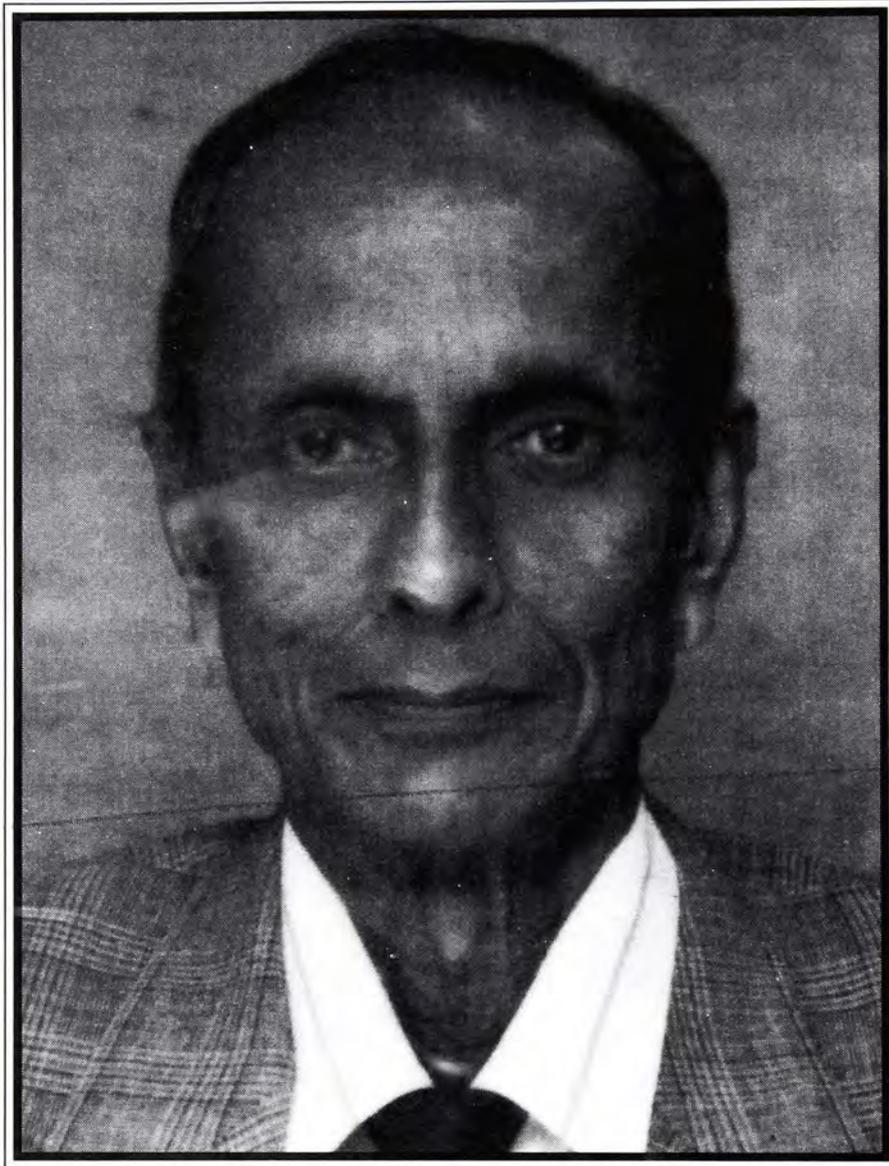


SIVARAJ RAMASESHAN
(10 October 1923 – 29 December 2003)

Biog. Mem. Fell. INSA, N. Delhi **29** 101-114 (2006)





Amas



SIVARAJ RAMASESHAN

(1923 – 2003)

Elected Fellow 1972

FAMILY BACKGROUND AND EDUCATION

SIVARAJ RAMASESHAN was born on 10th October 1923 to Sivaramakrishnan and Sitalakshmi, in Calcutta (presently re-named as Kolkata). His father, RBS Sivaramakrishnan, worked as Accountant General with the Government of India.

Ramaseshan was one among five brothers. One of the brothers was Dr Sivaramakrishna Chandrasekhar (1930-2004), a pioneer in liquid crystal research, and founder Director of Liquid Crystal Research Centre in Bangalore. Another brother, S Pancharatnam, made some outstanding contributions in optics in the 1950s and 60s, in the area of polarization and coherence phenomena. Pancharatnam died young (at 35) while working at Oxford.

Ramaseshan was one of the most outstanding scientists of modern India, with an illustrious family background that included an uncle and a first cousin who were both recipients of the Nobel Prize in Physics. His mother was the younger sister of: Sir CV Raman, who received the Nobel Prize in Physics in 1930 for his discovery of Raman Effect; and CS Iyer, an ICS officer and eminent musicologist, whose son Subrahmanya Chandrasekhar, an astrophysicist, received the Nobel Prize in Physics in 1983. CS Iyer's daughter, Vidya Shankar, now 84 years old, is a famous Veena player and an experts-committee member of the Madras Music Academy whose annual programmes in music and dance in the winter season attract huge audience with participants from all over the world. CS Iyer's grand-daughter, Dr Shantha, is a founder Director of the Cancer Institute in Chennai, and a recipient of the Magsaysay Award in 2005, for outstanding contribution in the treatment of cancer.

Ramaseshan's wife, Kausalya, is the grand-daughter of "Right Honourable" VS Srinivasa Sastry who, during pre-independence days, was conferred by the British government with the highest honour of membership of His Majesty's Privy Council, carrying with it the title "Right Honourable", in recognition of his services to the cause of world peace, disarmament, and democracy. He used his mastery of English language and eloquence to present India's case for self-government, in the councils of Europe. His speeches and statesmanship as the country's ambassador captivated the British and made them cognizant of India's great culture and civilization.



Ramaseshan was thus part of an extended family many of whose members distinguished themselves through outstanding contributions in science, arts and public service. He therefore did not have to look hard or far for inspiration or role models. In a career stretching over more than half a century, Ramaseshan blazed a trail of original research contributions in science that were recognized through several honours, fellowships and awards, including the Padma Bhushan award by the Government of India.

Ramaseshan had his earlier studies at Nagpur, graduating in 1943 with a B.Sc. (Honours) degree from the Science College, University of Nagpur, securing first class, first rank, and a gold medal. The same year he joined as a research scholar at the Physics department of the Indian Institute of Science, Bangalore to pursue research in physics, and work towards a doctorate degree under the guidance of his illustrious uncle, Sir CV Raman, Nobel Laureate. His doctoral thesis was titled: "Studies on the crystallography of diamond and on magneto-optic rotation." He submitted the thesis and obtained his D.Sc. degree in 1951 from the University of Nagpur, since IISc did not award degrees in those days.

PROFESSIONAL CAREER AND SCIENTIFIC CONTRIBUTIONS

Ramaseshan's main scientific interests were in the areas of optics, condensed matter physics, X-ray crystallography, and materials science.

After obtaining his doctorate degree in 1951, Ramaseshan continued his research work in optics as a faculty member of the department of physics at the Indian Institute of Science, Bangalore, where he worked till 1962. An invited review article on Crystal Optics published in 1961 in the prestigious *Handbuch der Physik* (Volume XXV) was the pinnacle of his research work in optics. This article was co-authored with GN Ramachandran, who was his contemporary and colleague earlier at the Physics Department, and also a student of CV Raman. GN Ramachandran had subsequently left Bangalore to become the Professor and Head of the Department of Physics at the University of Madras where he established a major school of crystallography that later came to be referred to, at the international level, as the "Madras School".

During 1954-55, Ramaseshan visited the Polytechnic Institute of Brooklyn in New York, to work on low temperature crystallography with Isadore Fankuchen. It was during this visit that he got interested in medical and biological applications of crystallography. Subsequently, his interests shifted to X-ray crystallography, and his research activities in this area saw him emerge as the leader of an influential school of crystallography at Bangalore. One of the major themes of his research work in crystallography was the application of the phenomenon of 'anomalous scattering of X-rays' by electron-dense atoms, for solving the "phase problem" in X-ray Crystallography. As a first step, he became interested in discovering a practical



solution to the phase problem for crystals possessing a centre of symmetry. He showed, by mathematical analysis, that the intensity data from a crystal, collected using X-rays at two different wavelengths close to the absorption edge of an electron-dense atom in the crystal, could be used to determine the signs of the amplitudes of X-rays diffracted by the crystal, and used this analysis, with his students K Venkatesan and NV Mani, to actually solve the unknown crystal structure of KMnO_4 , where Mn atom was the anomalous scatterer. Subsequently, he extended this analysis to describe a procedure for determining the phase angles unambiguously even for crystals that do not possess a centre of symmetry. This idea, published by him in 1957, in fact forms the basis behind the current popular procedure for solving the three-dimensional structures of crystalline macromolecules, by the so-called Multiple Anomalous Dispersion Method. It was also during this period that he collaborated with Prof. TR Govindachary, and with his student, H Manohar, determined the structure of the alkaloid, echitamine, whose chemical structure was a matter of intense controversy, involving four different groups of chemists at the international level. The structure determined by X-ray crystallography turned out to be different from that proposed on the basis of chemical evidence. The use of anomalous scattering from an iodide derivative permitted the determination of even the absolute configuration of the alkaloid.

This was also the phase during which the three famous "V" - graduate students Viswamitra, Venkatesan and Vijayan – enrolled with Ramaseshan to carry out their Ph.D. work in crystallography, and who subsequently went on to become full-fledged professors at the institute, and carved out a niche for themselves as eminent crystallographers both at the national and international level.

In 1962, Ramaseshan accepted a position as Professor and Head of the Department of Physics, Indian Institute of Technology, Madras. During 1964-65, while working at IIT-Madras, he visited the laboratory of Dorothy Hodgkins, Nobel Laureate, at the University of Oxford as a Senior Visiting Fellow, and worked on the solution of the X-ray crystallographic phase problem for determining the structures of large biological molecules. Dorothy Hodgkins had an important influence in his professional career, and she became a close family friend and a source of inspiration to Ramaseshan.

The academic atmosphere at IIT-Madras must have been a stark contrast to Oxford for Ramaseshan. An 'amusing' episode described by Professor CNR Rao (*Current Science* 2004 **86**(1) p 224), regarding a visit he made to Madras to meet Ramaseshan during this time is quoted below:

"On one occasion,my family and I visited the Ramaseshans in IIT Madras on our way from Kanpur to Bangalore..... Sivaraj came home from the department to be with us, but we had the nagging fear that the Director of the Institute would call up Sivaraj to enquire why he had gone home during working hours. The Director



had the reputation of being a strict headmaster, who kept a note of the whereabouts of professors and about their hours of arrival and departure from the departments."

Writing about his impressions of the time when Ramaseshan was at IIT-Madras, Rajaram Nityananda makes the following observations: "... (Ramaseshan)... with his remarkable breadth and talents, and his charismatic impact on students, the IIT could well have become an academic niche in which he would have built up a strong department and training programme for physicists and engineers in India" (*Current Science* (2004) **86**(1) 220).

In 1966, Ramaseshan moved back to Bangalore to take up a position as Head of the Materials Science Division at the National Aeronautical Laboratories (NAL) (presently National Aerospace Laboratories), to set up a materials science laboratory. An important aspect of his research at NAL was on physics at high pressures. In this connection, he spent a few months in 1969 as a Visiting Scientist at Bell Telephone Laboratories in Murray Hill, New Jersey, USA.

His stay at NAL was probably the most exciting phase of his career, characterized by outstanding contributions to materials science research with important applications in several areas. The materials science program initiated by him played a critical part in the development of India's capabilities in aerospace research. This phase of his career was also remarkable for some noteworthy collaborative research activities with other institutions, leading to his contributions to the development of heart valves, blood bags and components for aerospace applications.

To quote from the website of the Indian Academy of Sciences, during his stay at NAL, Ramaseshan "established the first high-pressure laboratory" in the country and the "first materials science laboratory", "designed and fabricated the first nutation damper for India's satellite Aryabhata; the FRP porous tubes for desalination; and materials and processes for India's first heart valve prosthesis".

While at NAL, Ramaseshan also served as the Acting Director of Raman Research Institute during 1970-72. In 1979, Satish Dhawan, Director of the Indian Institute of Science, Bangalore, invited him back to the institute as Joint Director. In 1981, he became the Director of the Institute, and served till 1984 when he retired from formal service. During 1983-85, he also served as President of the Indian Academy of Sciences for a three-year term.

Retirement only meant a new beginning for Ramaseshan to pursue his other academic interests. He became an Honorary Distinguished Professor Emeritus at the Raman Research Institute in Bangalore, a position he held till his death.

His post-retirement activities were just as outstanding for their productivity and relevance as were his in-service research contributions. He took over the responsibility of the administration of three legacy institutions started and nurtured



by his uncle CV Raman - the Indian Academy of Sciences, Raman Research Institute and Current Science Association. After Raman's death, these institutions needed extraordinary leadership and momentum to keep alive the concepts and ideals envisioned by Raman, and Ramaseshan shouldered the responsibility of revitalizing these institutions with admirable grace and aplomb. Ramaseshan was a gentle person, soft in manner and speech, but beyond his preternatural affability, there was lot of steel as well!

Ramaseshan was one of the founders and first chairman of the Governing Board of Astra Research Centre in Bangalore, an institute specializing in biological and pharmaceutical chemistry. He co-authored an illustrated biography of CV Raman with Raman himself and C Ramachandra Rao.

RAMASESHAN AS EDITOR

In 1971, Ramaseshan was elected as the vice-president of the Indian Academy of Sciences, and in 1973, on behalf of the Academy, he was instrumental in starting a new physics journal, *Pramana*, for which he became the founding editor. The journal was published in collaboration with INSA (Indian National Science Academy) and the Indian Physics Association.

As the motivating force behind the launch of *Pramana*, Ramaseshan wrote in an editorial: 'The publication in foreign journals of the major part of the work done in India today is having a deleterious effect on Indian science. Relegating the refereeing of our best scientific work leads to loss of judgement and self-confidence. This process has sapped the inner resources of Indian scientists and, among other things has led them to follow blindly fashions set elsewhere in choosing fields of work'.

In 1977, he was appointed as the first editor of publications for the Indian Academy of Sciences, a position he held till 1982.

In 1989, he took over the editorship of "Current Science", another journal published by the Indian Academy of Sciences. This journal had an illustrious past, but had fallen on bad times. A chance comment in the scientific circle that "Current Science" is perceived to be a dull journal fit only for farmers (probably due to predominantly agriculture-related articles), made him swear to change that negative perception and rejuvenate the journal. Enlisting the help of Professor P Balaram at the Indian Institute of Science, he quickly brought about an amazing transformation of that journal, thereby making *Current Science* as one of the most outstanding journals published from India – a journal that could now proudly claim enhanced visibility, prestige, and content of science. Out of some 45 Indian journals used in a 2002 survey of popularity, *Current Science* was now found to hold the top rank, with an impact factor of 0.600 in contrast to the value of 27.9 and 23.3 enjoyed by the popular international journals, *Nature* and *Science* respectively. To put the numbers in perspective, one may note that the international journal *Acta Crystallographica*,



Section C, Crystal Structure Communications consulted by chemists and crystallographers the world over, and who constitute its largest audience, has an impact factor of 0.659. The most popular Scientific American has an impact factor of 2.05.

Ramaseshan's passing away means that *Current Science* lost its most dedicated editor, but hopefully its future editors will ensure that the legacy left behind by Ramaseshan will continue to prosper. I would refer the readers to a thoughtful editorial written by P Balaram in *Current Science*, Vol. 88(12), 25 June 2005. It would be nice to see the day, in the not too distant future, when surveys would reveal that *Current Science* has acquired an impact factor in the upper 20s, if not higher. That would be a fitting monument to the memory of Ramaseshan.

Ramaseshan also edited two books on the 'Scientific papers of CV Raman', and the 'Collected Works of Dorothy Crowfoot Hodgkin.'

RAMASESHAN AS A HUMAN BEING

If one were to sum up Ramaseshan's life, it was a life dedicated to science, and more science, with a cherished vision to put Indian science on the world map.

Ramaseshan was a great scientist full of wit and wisdom, a scholar and visionary, leader and mentor. He was extraordinarily human; one cannot talk about him without recalling the tremendous warmth and affection that he displayed when interacting with students and colleagues.

Ramaseshan was a builder of groups, institutions, scientific organizations and academies. He was the prime architect of a movement to enhance the prestige, visibility and content of scientific journals published from India.

Whatever the sphere of activity that Ramaseshan got involved with, he made a distinctive and lasting contribution.

Ramaseshan literally breathed science and to the very end it was talk of science and scientists that made him sparkle, even when the ravages of illness had begun to take their toll.

Long after his retirement, in spite of his old age, he used to frequent the library facilities of Raman Research Institute, attend seminars and Journal Club meetings like he was still young. To use his words, this kept his "mind and brain comparatively active".

Ramaseshan was always informal in his interactions with his students and associates, and one always ended up forming lifelong friendship with him. He was easy to work with, unhesitatingly generous and open to discussions. He encouraged students to do their best and develop their interests and ideas. He was intimately involved in their work, moving from desk to desk in the laboratory discussing



progress and problems. He would even stay late at night in the laboratory and help students in the laborious calculations. Rarely does one “come across a scientist like Ramaseshan in whom the attributes of a great researcher coexist with the warm qualities of a wonderful human being.” (K Venkatesan and H Manohar, *Current Science* (2004) **86(1)** 222).

He was an outstanding lecturer and conversationalist, with a self-deprecatory humour, the hall-mark of an extraordinarily self-confident individual, devoid of the sense of insecurity that plagues many a scientist.

Ramaseshan’s lectures “...were carefully prepared and intensely delivered, with sharp sallies of humour, illuminating and insightful digressions into history and interconnections between different subjects, and generous acknowledgment of colleagues. (And) this was not just characteristic of his lectures only but reflected his way of doing science. (R Nityanand, *Current Science* (2004) **86(1)** 220).

Dr Abdul Kalam, President of India, in a speech delivered at the Indian Institute of Science, Bangalore, on 14th October 2004, fondly remembers the role played by Ramaseshan in launching his career, referring to Ramaseshan as the “mighty soul” who was instrumental in getting him appointed in the defence department of the Government of India - DRDO, (Defence Research and Development Organization), vide report found at the website <http://presidentofindia.nic.in/scripts/speecheslectures.jsp>

According to CNR Rao, Ramaseshan “...stood for excellence without being arrogant. He carried his accomplishments and recognitions lightly. He was a good communicator without being pompous. He loved people because it was his nature. He loved life and laughed easily.” (*Current Science* (2004) **86(1)** 223)

Those who knew him personally were immeasurably impressed by his simplicity of style and empathising spirit. In his death, science in India has lost a 'saintly' practitioner.

LAST DAYS

Towards the end, Ramaseshan had been less than his usual self, due to persistent and multiple illnesses, and the last two years prior to his death were particularly trying for him, his close family, and large circle of friends, well wishers and admirers. He breathed his last on 29 December 2003. He is survived by his wife and three daughters.

HONOURS, DISTINCTIONS AND AWARDS

Ramaseshan has been honoured with many fellowships and awards during his illustrious career. Some of the most prominent ones are listed below:



- 1955 Elected Fellow, Indian Academy of Sciences, Bangalore
- 1972 Elected Fellow, Indian National Science Academy (INSA)
- 1970-72 Acting Director, Raman Research Institute, Bangalore.
- 1974-76 Member, INSA Council
- 1977-79 Jawaharlal Nehru Fellow
- 1971-79 Vice President, Indian Academy of Sciences
- 1977-82 Editor of Publications, Indian Academy of Sciences
- 1983-85 President, Indian Academy of Sciences.
- 1989-03 Editor, Current Science International Union of Crystallography:
- 1969 Chairman & Organizer of Frontier Topics in X-Ray Crystallography, IUCr Congress at Stony Brook, NY
- 1974 Chairman & Organizer of Conference on Anomalous Scattering, IUCr Congress in Spain.
- 1980 Chairman, National Organizing Committee for the IUCr Summer School on Crystallographic Computation.
- 1975-84 Member, Executive Committee
- 1981-84 Vice-President
- 1962 Bhatnagar Award
- 1980 Vasvik Award (Materials Science)
- 1985 INSA - Aryabhata Medal
- UGC National Lecturer
- Member, Governing Body of Sree Chitra Thirunal Medical Centre, Trivandrum.

SUMMARY OF SCIENTIFIC WORK

Research Areas: Crystallography, Optics, Condensed Matter Physics, Materials Science.

Crystallography

- Multiwavelength anomalous X-ray scattering method for the determination of phases of reflection;
- Partial structure factors of binary liquids and glasses;
- Static displacements; and polarization vectors.
- Use of anomalous neutron scattering for solving very large structures.
- Showed that the resistivity anomaly in liquid caesium is due to anomalous electron scattering during the Fermi 6s-5d electron collapse.



- Formulation and verification of laws governing cleavages in crystals.
- Discovery of the icosahedral coordination in ionic solids.
- Development of new techniques for low temperature crystallography.

Optics

- Fresnel diffraction in transparent spheres and spheroids;
- Optical activity of neutrons in halimagnetic structures;
- Crystal optics based on the Poincare sphere.
- Condensed matter physics:
- Established the first high pressure laboratory in India;
- Predicted pressure-induced optical activity;
- Predicted and verified the existence of pressure-induced liquid crystallinity;
- Determined the critical point in solid-solid isostructural transformation of SmS.

Materials Science

- Established the first materials science laboratory in India.
- Designed and fabricated the first mutation damper for India's satellite Aryabhata;
- FRP porous tubes for desalination;
- Materials and processes for India's first heart valve prosthesis.
- Has published a total of 178 papers during the years 1944-2000

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(B) Review Articles:

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 1964 *Anomalous Scattering in Structure Determination—Recent Advances in X-ray Crystallography*, Academic Press
 — (With VEDAM K), The photoelastic effect in crystals – *Progress in Crystal Physics*, Academic Press 102-138
 — (With KRISHNAN RS and VEDAM K), Thermo-optic behaviour in Crystals - *Progress in Crystal Physics*, Academic Press 139-167
 — The Faraday Effect in Diamagnetic Crystals - *Progress in Crystal Physics*, Academic Press, 168-183

(C) Research Articles:**(i) Optics:**

- 1949 (With RAMAN CV) The Christensen experiment with spherical particles *Proc Ind Acad Sci* **36A** 211
 — (With RAMAN CV) The diffraction of light by transparent spheres and spheroids *Ibid* **30A**
 1955 An analyser for elliptically polarised light *J Ind Inst Sci* 37
 1964 (With RAJAGOPALAN SR) Rotating elliptic analysers for the automatic analysis of polarised light Parts I and II *Proc Ind Acad Sci* **60A** 383-391

(ii) Optical Properties of Materials:

- 1944 The magneto optic anomaly in optical..... *ibid* **25A** 126
 — The Faraday effect in cubic crystals I *Ibid* **25A** 460
 1946 Faraday Effect in diamond *Proc Ind Acad Sci* **24A** 122
 1948 Faraday effect in cubic crystals II *Ibid* **28A** 360
 1950 Magneto optic anomaly in Electrolytes and.....II **31A** 149 172
 1951 The Faraday effect and birefringence I. *Proc Ind Aca Sci* **34A** 32
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 — (With CHANDRASHEKHAR V) Faraday effect and birefringence *Curr Sci* **20** 15
 1954 A magneto optic method for the determination of piezo optic coefficients *Proc Ind Acad Sci* **40** 184



- Formulation and verification of laws governing cleavages in crystals.
- Discovery of the icosahedral coordination in ionic solids.
- Development of new techniques for low temperature crystallography.

Optics

- Fresnel diffraction in transparent spheres and spheroids;
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