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## MEMORIAL OF CHANDRASEKHARA VENKATA RAMAN

November 7, 1888–November 21, 1970

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It is with deep regret that we record the death of Professor Sir C. V. Raman, a Fellow of the Mineralogical Society of America, on November 21, 1970 at his residence in Bangalore, India after a heart attack. In his death the world and India in particular lost a great genius: it was not only a loss to physics, but also to every field concerned with the properties of crystals.

Raman was born on November 7, 1888 at Trichinopoly, South India, and educated at Hindu College, Vishakapatnam, where his father was a professor of mathematics and physics. Later he attended Presidency College, Madras, from which he graduated with a B.A. degree at the top of his class, at the early age of 16. He also received the College Prize for English. Three years later he was awarded the Master's degree there with honors. While still an undergraduate he started his original investigations in acoustics and optics, and published his first paper at the age of 18 in the *Philosophical Magazine* of London in 1906.

At that time, Raman did not foresee "the possibility of a scientific career"—a field then hard for an Indian to enter. So after winning first place in the competitive examination, he entered the Indian Finance Department under British rule and served as an Assistant Accountant General in Calcutta, Rangoon, Nagpur, and again in Calcutta. During this time, however, his zeal for scientific research could not be suppressed. He continued his research, working nights and weekends at an improvised laboratory at his home as well as at the laboratory of the Indian Association for the Cultivation of Science at Calcutta. During the 10 years that he spent with the Finance Department, he published no less than 30 papers in various journals such as *Nature*, *Philosophical Magazine*, *Physical Review*, etc. The first bulletin of Indian Association for the Cultivation of Science contained a paper by Raman entitled "Experimental Study of Huyghens' Secondary Waves." He became a Curzon Research Fellow in 1912 and in 1913 was awarded the Woodburn Research Medal. In

1915 he founded the Indian Journal of Physics, of which he became the editor in 1921.

His success in research caught the attention of Sir Asutosh Mukerjee who was then the Vice-Chancellor of Calcutta University. He offered Raman the newly endowed Palit chair in Physics at Calcutta University in 1917. Without any hesitation, Raman decided to give up his comfortable position and accept Mukerjee's offer even though this meant considerable financial loss. He held this position for 16 years, and during this period he and his students made significant and fundamental contributions in numerous fields such as vibrations and sound, musical instruments, propagation of light in crystals and minerals, magnetic properties of crystals, X-ray diffraction and crystal structure, thermal properties of solids, and scattering of light.

In the summer of 1921 he made his first brief visit to Europe as a delegate to the Universities Congress held that year at Oxford. This visit abroad gave him the firsthand opportunity of observing the beautiful blue opalescence of the Mediterranean Sea. This was the starting point for a series of systematic studies on the scattering of light by material media which finally led to the discovery, nearly seven years later, of the effect known after his name.

In 1924, barely seven years after he became a Professor of Physics, he was elected a Fellow of the Royal Society. In the same year he was invited to open a Symposium on Light Scattering at the Toronto meeting of the British Association for the Advancement of Science. Subsequently, he represented India at the Centenary of the Franklin Institute in Philadelphia. During this visit he accepted the invitation of Professor R. A. Millikan and spent four months at the California Institute of Technology. The next year, Raman represented India at the bicentenary exercises of the Soviet Academy of Sciences in Leningrad and Moscow, and lectured at the Mendelejeff Congress.

The Raman Effect, first announced in the Indian Journal of Physics in 1928, was named by the Royal Society of London as "among the best three or four discoveries in experimental physics of the decade." The discovery not only opened up a new branch of spectroscopy, it has contributed enormously to our knowledge of the structure and dynamics of molecules and crystals. Recently, the Raman Effect has been exploited in the design of masers and lasers, to make available more frequencies than would otherwise be possible. The fact that nearly 10,000 papers have been published so far on Raman Effect and allied phenomena from all over the world speaks for itself of the importance of this discovery.

For this discovery, Raman was awarded the Matteucci Medal of



C. V. RAMAN

the Societa Italiana delle Scienze in 1928, was knighted by Great Britain in 1929, was awarded the Nobel Prize in Physics in 1930, the Hughes medal of the Royal Society of London in 1930, and received honorary degrees from numerous universities all over the world.

In 1933 he moved to the Indian Institute of Science, Bangalore, where his interests in crystal physics began to blossom rapidly. Over and above his prolific and continued interest in the various aspects of scattering of light by different materials, he initiated and successfully carried out numerous studies on a wide spectrum of topics such as crystal optics; magnetic anisotropy of crystals; vibration spectra of crystals; structure and properties of diamond; luminescence and absorption spectra of crystals; elastic, elasto-optic, thermo-optic, and magneto-optic behavior of crystals; thermal properties; X-ray diffuse scattering, and so on.

After retirement from the Indian Institute of Science in 1948 he started an Institute of his own with the sponsorship of the Indian Academy of Sciences which he had founded in 1935, in the hope that it would "become an international cultural center that would show India's greatness in the field of exact sciences." Immediately on his retirement, Professor Raman was appointed as the first National Professor by the government of India, a position which he held until his death. The Raman Institute, besides being well equipped for research in the fields of spectroscopy, optics, X-rays, crystal physics, and mineralogy, houses an outstanding museum attached to the Institute containing a magnificent collection of rocks and minerals, and possibly the largest collection in the world today of diamonds for experimental investigations. Also housed in the museum are colorful specimens of corals, shells, and various butterflies.

His interests in later years were mainly focused on finding a satisfactory explanation of the floral colors and the physiology of human vision. For his continued and relentless pursuit of science, honors continued to pour in. In 1941 he was awarded the Franklin medal, the title "Bharat Ratna," the highest honor by India in 1954, the Lenin Prize in 1957, elected as an honorary fellow of the Optical Society of America, foreign Associate of the French Academy, corresponding member of the Russian Academy of Sciences, member of the Pontifical Academy of Sciences by the Pope in 1961, fellow of the Mineralogical Society of America, and memberships in numerous other scientific societies throughout the world.

The list of publications of Professor Raman, his students and his collaborators runs into many pages. More than one thousand and two

hundred original contributions have emerged out of his laboratories. Professor Raman was not only a great investigator but also a great teacher in the true sense of the word. His ideas and personality attracted many young research students and he held their loyalty and affection by extending a never-failing friendship to them. He not only taught methods of scientific research to his students, but by his own example made them realize the necessity of endurance, steadiness and hard work in the pursuit of knowledge.

The feelings of respect and admiration which his students retain towards him can be ascribed to his fairness or even magnanimity in allowing most of the publications of his students to appear in their own names, even though he may have suggested the problem, provided the facilities, interpreted the results, and even written whole sections of the papers. Whenever he discovered any originality in any pupil, he did all he could to develop it. The *Journal of the Optical Society of America* recently stated "Raman's participation in the training of more than 500 young Indian scientists constitutes one of his most enduring and far-reaching accomplishments, for which not only India but the world should be everlastingly grateful."

His greatness lay not just in his specialized field of research but in his extent of knowledge, his eagerness to collect and read books on other subjects in literature, music, science, and technology. His lectures to a lay audience made him especially noteworthy. He could capture the attention of school children, college students, and townspeople equally well. Possessing in a rare measure the extraordinary gift of making the most difficult problems in physics appear simple and with a keen and irresistible sense of humor, he would have the audience roaring in laughter every few minutes.

The saying "there is always a woman behind every great man" is very true in Raman's life. Lady Lokasundari Raman was a wonderful wife and very interested in mothering all her husband's students. But for her ever loving care and shouldering the unavoidable worries of the day to day existence, Professor Raman would hardly have been able to devote himself so wholeheartedly to scientific research.<sup>1</sup>

<sup>1</sup>To obtain a copy of a selected bibliography of Raman's works, order NAPS Document Number 01714 from National Auxiliary Publications Service of the A.S.I.S., c/o CCM Information Corporation, 866 Third Avenue, New York, N. Y. 10022; remitting \$2.00 for microfiche or \$5.00 for photocopies, in advance, payable to CCMIC-NAPS.