



**Kariamanikkam Srinivasa Krishnan: His Life and Work Author: D.C.V Mallik and S. Chatterjee; Published by Universities Press (2012), Pages: xxiii + 461. Price: Rs. 895.00**

The book speaks more than what the title suggests. This is not only the story of one of the foremost scientists of India who rose to the top by his merit and determination but also presents a fascinating tale of the socio-political scenario of scientists and scientific organizations of India prevailing during early to mid twentieth century. The book also elicited a revealing story layer by layer about the buried controversy that Krishnan was deprived of the well-deserved credit of sharing the Nobel Prize with C.V. Raman. The book is a product of intensive research on Krishnan's life and surroundings and has been presented in a style which makes the book more gripping. Authors D.C.V. Mallik and S. Chatterjee made a great effort to collect documents including Krishnan's personal diary, and meet various people known to Krishnan to make the book an authentic history of Krishnan's life. Authors being physicists have

been able to present the physics on Krishnan's work on light scattering, Raman scattering and magnetism in a lucid yet scholastic way. On reading the book the reader will be able to understand all other facets of Krishnan's life to understand him as a complete man. The book will be inspiring to students and young scientists especially to physicists and will be enjoyed by anyone interested in social science and history of science.

Kariamanikkam Srinivasa Krishnan was born in 1898 at Watrap, a village north of Vizhupanoor in Madras (now Chennai). Incidentally, Kariamanikkam is the family name derived from their faith in *Kariamanikka Perumal* or Lord Vishnu. Krishnan's father was a Brahmin scholar in Sanskrit and Tamil while his mother Nachiyar was an accomplished lady who along with social and familial work was involved in purchasing and selling of agricultural land and managed the land affairs with great acumen.

Born and educated in a period when the world was witnessing a series of revolutions in political as well as intellectual lives, marked by a series of discoveries which revolutionized our concept and understanding of the nature of the physical world, influenced his life and character and paved the way to his becoming a scientist. The whirlpool of discoveries of X-rays (1895), electron (1897), radioactivity (1896), Planck's quantum hypothesis (1900), quantum concept of photoelectric effect (1905), special theory of relativity (1905), atomic nucleus (1912), Bohr's atomic theory (1913), general theory of relativity (1916), wave-particle duality (1924), Raman's work on light scattering etc., influenced his selection of science research.

Like a true genius, while taking his first lesson in physics on Archimedes' principle in fifth class in school, he independently discovered an instrument to measure the density of a substance only to realize later that he had re-discovered Nicholson's hydrometer. Krishnan had his school education in Hindu School near his native town and graduated from the Christian Missionary College in Madras. However, his desire and determination to conduct research in science prompted him to bail out of jobs which were trivial and routine in nature. All through his life, he never compromised on his passion for science research and refused many good offers.

His journey to enter into the world of science finally landed him in Calcutta (now Kolkata), the intellectual

'mecca' at that time. Calcutta was somewhat privileged in terms of education, infrastructure and many other aspects from being the capital of India during the period 1772 till 1911. The British took many steps on education and entertainment which led to establishment of many institutions which were the 'first' of its kind in India. The first academic society, known as Asiatic Society, was established in 1784; in the same year the first official newspaper (*The Calcutta Gazette*) was published; the first native football club was established; the first university was opened in Calcutta in 1857 followed by others in Bombay and Madras; the first science research laboratory of the country- the Indian Association for the Cultivation of Science (IACS)—was established by Dr. Mahendra Lal Sircar in Calcutta in 1876 long before science courses were started in Calcutta University (1914). Sir Asutosh Mukherjee, the then Vice-Chancellor of Calcutta University, was a man with profound foresight of recognizing talent and appointed Sir C.V. Raman, with no formal degree in physics as Palit Professor of Physics, D.M. Bose as Ghosh Professor of Physics without a doctorate degree and three other young scientists S.K. Mitra, M.N. Saha and S.N. Bose as lecturers in the department. Aspiring young minds quenched their thirst for science by attending lecture demonstrations by distinguished scientists like Acharya J.C. Bose, Acharya P.C. Ray, Father Lafont of St. Xavier's College etc. at IACS. The pioneering work of Raman and others carried out at IACS attracted the best minds from all over the country for research and Krishnan was no exception — Krishnan arrived in Calcutta in July 1920 to meet Raman and to work with him.

Calcutta in 1920 was not only charged with the atmosphere of political struggles and freedom movement but was also a breeding place of revolutionary ideas. In such an environment, young Krishnan could not be oblivious to his surroundings and was drawn into active politics. He started wearing *khadi* and attended every meeting of the Congress. His involvement was so deep that he was selected as one of the student representatives from Calcutta to attend the India Students' Convention, a part of the Congress session, in Nagpur. However, he was dissuaded from attending the convention by his teacher and finally concentrated on studies.

Raman advised Krishnan to enroll as an M.Sc. student of physics in the University of Calcutta before starting research in physics. Fifty one students in the M.Sc. physics class of 1920 is awesome number when compared to seventy-eighty students in current days M.Sc. physics course. However, Krishnan never appeared in M.Sc. Examination of the University of Calcutta but obtained his

masters degree from the University of Madras on the basis of his research. He also obtained a D.Sc. degree from the University of Madras on the basis of his published papers with impressive recommendations from his thesis examiners Edmund C Stoner, one of the founders of magnetism, Owen Richardson, a Nobel Laureate for his work on thermionic emission and W.H. Bragg, another Nobel Laureate who shared the Nobel Prize with his son W.L. Bragg.

Krishnan started working with Raman on scattering of light from liquids and vapours under various physical conditions to study the electric, magnetic and optical properties of liquids and gases. Scattering of light and Raman effect have been discussed in detail with appendices at the end in a manner that general readers will find interesting while students and teachers will find illustrative and instructive.

Although 28<sup>th</sup> February 1928 is considered as the official date on which the Raman Effect was discovered, the actual stage was set almost five years ago. In fact, had Raman accepted the quantum theory of photon, which was clearly established experimentally by Compton known as 'Compton Effect', the Raman Effect could have been discovered much earlier. It is to be understood that Raman Effect is a quantum mechanical effect and can not be explained classically. In 1923 Raman and his student Ramanathan observed a trace of radiation of different colour (wavelength) in the scattered beam of light from water and ethyl alcohol. Although the presence of a trace radiation of longer wavelength bothered Raman, there was lack of serious investigation to understand the physical reason behind it, presumably due to the departure of Ramanathan from Raman's group. On 7<sup>th</sup> February 1928, Krishnan observed this effect again in the scattering of light from aliphatic and aromatic liquids, and when reported, Raman considered it as the confirmation of classical Kramers-Heisenberg effect, rather than Smekal effect which was based on a quantum mechanical system having discrete energy states. It was only after the announcement of Nobel Prize to Compton in December 1927 that Raman told Krishnan 'if this is true of X-rays, it must be true of light too. There must be an optical analogue to Compton effect'. With this started the concerted effort of Raman and Krishnan to understand the true nature of the weak fluorescence observed by Ramanathan five years ago and finally the Raman Effect came to light.

There is a common perception and sentiment among a section of physicists that Krishnan was deprived of the recognition he deserved in sharing the Nobel Prize. The authors have shed some light on this quandary on the basis of evidence obtained from the diary Krishnan

maintained at that time, conversations and from other sources. The mystery could be solved beyond doubt if the diary that Krishnan maintained was available in full. The diary that Krishnan's family now possesses has only 16 pages covering the period of February 5 to 28 with the entry on the last day ending abruptly at an unfinished sentence that had started to describe the actual discovery. Records of all subsequent work and events up to April 1928 were also missing leaving us in a fix. However pages of his diary and the anecdotes of Krishnan's colleagues gave us enough reasons to believe that Krishnan was the co-discoverer of Raman Effect. According to the diary of 9<sup>th</sup> February, after the visual demonstration of the 'modified scattering' Raman said that "the phenomenon should be called Raman-Krishnan-Effect". The first paper titled 'A new type of secondary radiation' announcing the discovery was jointly authored by Raman and Krishnan which was dispatched within a week of the experiment on 16<sup>th</sup> February 1928 for publication in the form of a letter to *Nature*. According to the diary on 28<sup>th</sup> February, Raman and Krishnan decided 'to examine the influence of the wavelength of the incident light on the phenomenon'. After that one has to depend on circumstantial and other evidences. On 8<sup>th</sup> March 1928 Raman sent another letter in his single authorship titled 'A change of wavelength in scattering' in *Nature*, although some of the conclusion was drawn in haste and was not correct. On 22<sup>nd</sup> March Raman and Krishnan sent a third letter titled "The optical analogue of the Compton effect' to *Nature* which gave the correct quantum-theoretical explanation of the scattering effect. Raman had an acute sense of timing and judgment and soon he submitted a full-length paper for publication to the *Indian Journal Physics* of which he was the editor. Taking advantage of the authority of being an editor, he did not wait for the formal publication of the paper but prevailed upon Calcutta University Press to print the paper immediately and arranged for hundred copies to be posted all over the world on the same day. These four publications are known as 'discovery papers' and in all of these Krishnan had enough contributions. In a conversation to one of his students Sukumar Sirkar, Raman had said that 'Krishnan deserved half the credit for the discovery and that he would share with Krishnan any reward that came to him for it'. There was a complete reversal in Raman's actions later, as he started projecting himself as the sole discoverer ignoring Krishnan's contributions and approached Rutherford and Bohr to nominate him to the Nobel Committee for 1929 prize in physics.

Immediately after the discovery of Raman Effect, Krishnan took a conscious decision to join Dacca

University as a Reader in the Department of Physics and it is interesting to note that he never worked on Raman Scattering. His attention was directed to magnetism and during his stay in Dacca (1928-1933) and at IACS in Calcutta (1933- 1942) as M.L. Sircar professor, he worked on diamagnetic anisotropy to understand molecular orientations in crystals; role of electric field in influencing the magnetic behaviour of crystals and magnetic anisotropy in paramagnetic crystals at low temperatures. While he was at the IACS he initiated the first cryogenic research in India. Krishnan was unusually adept in theory and experiment. He had maintained the legacy of Acharya J.C. Bose, C.V. Raman and others of producing highly sensitive instrument out of available resources using ingenious technique. Unfortunately this genre of scientists no longer exists.

After leaving Calcutta in 1942, Krishnan completed a brief stint at Allahabad University and finally joined the National Physical Laboratory (NPL), Delhi, in April 1948 as its first Director. In spite of his distaste for administrative and bureaucratic responsibilities, his accepting of the position at NPL was in response to the call of the nation to develop a laboratory to maintain fundamental and derived standards and to undertake research to achieve greater accuracy in the measurement of those standards. He also managed to eke time from his busy schedule as Director to continue research in the areas of lattice oscillations in ionic crystals and thermionic properties of metals and semiconductors.

This book presents the well-known north-south polarization of Indian scientists as well as the controversy surrounding Raman's insistence to include his wife Lokasundari and brother C. Subramanyan Ayyar in the management committee of IACS after he became its Secretary in 1919. After controlling the affairs of the IACS for fourteen years, Raman left to join the Indian Institute of Science (IISc), Bangalore, as its Director. In the same year in a single stroke, in the meeting of the management committee of IACS, Raman appointed Krishnan as Mahendra Lal Sircar Professor of Physics and Secretary of IACS and himself as its President. The conflict between two groups of scientists, one around Meghnad Saha and the other around Raman in connection with the formation of academies for scientists of India reached such a nadir that by 1935 there were three science academies— one in Bangalore, one in Allahabad and one in Calcutta. The authors had mentioned the publication of the journal *Current Science* by Raman as the mouthpiece of the academy in Bangalore but did not talk about the publication

of the journal *Science and Culture*, around the same time by Saha.

By temperament Krishnan was a modest person and was patriotic in nature. In fact Sarojini Naidu (then Governor of UP) once said in a meeting at Allahabad “you are too modest and too unassuming” and advised him to be “arrogant”. This temperament explains his loyalty and respect to C.V. Raman throughout his life, and he could be counted upon to come forward to help his *Guru* in his times of trouble. Krishnan was instrumental in nominating Gandhi for Peace Nobel Prize of 1947 first convincing Harald Wergeland, a Norwegian theoretical physicist who was closely associated with the Nobel Committee for Peace Prize, whom he met in a meeting to nominate Gandhi and then persuaded Rajagopalachari for a document on Gandhi to be sent to the committee.

After the death of S.S. Bhatnagar in 1955, Krishnan was invited to become the Director of CSIR (Director-General in today’s parlance) but he refused it as it would

have encroached upon the little time for research he had after fulfilling his responsibilities as Director of NPL. Krishnan received many prestigious awards in India and abroad, but he was also immensely knowledgeable in subjects other than science, such as Sanskrit, philosophy, mythology and Tamil literature. More importantly, Krishnan believed that science was an essential component of culture and was concerned about its integration in the general fabric of culture for the progress and prosperity of our civilization. A scholar with precocious intelligence yet unassuming simplicity, Krishnan had a peaceful end of his life in the evening of 14 June 1961 while reading a book after dinner.

The first Earl of Lytton, who had served as the Viceroy of India, had written that “Genius is master of man; Genius does what it must and talent does what it can”. The entertaining biography provides a clear account of Krishnan’s life and work, and makes it easy for readers to decide what Krishnan was. □

**S.C. Roy**