

VOL. XXII NO. 22, MARCH 1-15, 2013

The illustrious scientist who teamed with C.V. Raman

By T.K. Srinivasa Chari

"The first four decades of the 20th Century were glorious years for science, especially physics. Our view of the physical world changed forever with the emergence of quantum mechanics and Einstein's formulation of the theory of relativity. India too contributed significantly to this scientific revolution with the discoveries made by S.N. Bose, C.V. Raman and M.N. Saha, all in the space of about a decade. Kariamanikkam Srinivasa Krishnan (1898-1961) belonged to the same illustrious group. He was perhaps the only Indian physicist of his generation who was equally adept in theory and experiment. Besides a life of excellence in science, Krishnan's destiny led him to be an able science policy maker and administrator. He was also a great teacher, a humanist and a scholar of Sanskrit, Tamil literature and philosophy."

– From the biography: *K.S. Krishnan, His Life and Work* by D.C.V. Mallik and S. Chatterjee (Universities Press, Hyderabad, 2012).

Taking more than nine years to complete, this 460-page biography by two professors of Indian Institute of Astrophysics is ideal reading for researchers, students and general readers. What is significant for the ignorant is that their attention is drawn to the contribution of K.S. Krishnan as the co-collaborator in the discovery of the Raman Effect which won for C.V. Raman the Nobel Prize for Physics in 1930, the first time any Asian or non-White received the prestigious award in Science.

Krishnan was born in Vizhupanoor, spent his childhood in nearby Watrap and studied in the Hindu School in Srivilliputtur, all in



*A portrait of K.S.
Krishnan.*

the same district of Madras Province. Among his schoolmates were Ramaswamy Raja and Kumaraswamy Raja (Rajas, a deviant of Rajus, of Andhra Pradesh) who settled in a place which took their name, Rajapalayam. Kumaraswamy Raja later became Chief Minister of Madras. Ramaswamy Raja established the first industries in the region, today known as the Ramco group. The two Rajas and Krishnan are known as the 'Great Trio' of the Hindu High School of Srivilliputtur. Krishnan, after passing the Matric exam, joined the Fine Arts class of the American College in Madurai in 1914 and excelled in Science, English and Tamil. His first exposure to tennis was here, and developed into a lifelong passion for the sport.

Krishnan left Madurai for Madras and joined Madras Christian College (MCC) in George Town. He took his BA in 1918, when he won the Aberdeen Prize awarded for the most outstanding student of Physics. He did exceedingly well in Chemistry too but, strangely, did not pass in English and had to take the paper the next year to get his degree. He then went back to his native Watrap, and took up the position of headmaster of the Hindu School where he had studied. But soon, to his joy, he was offered the post of Demonstrator in the Chemistry laboratory of MCC. He returned to Madras, a city he had fallen in love with, and lived in Linghi Chetty Street. As Demonstrator, he did more than what was required of him, stopping by at each student's table and explaining the details of the observations to be made and how to record them in their notebooks. If things went wrong, he would often 'demonstrate' the precise way of doing an experiment. After his appointment was made permanent, he began going, in addition to the daily ritual of visiting the college library, to the Connemara Public Library in Egmore to peruse the then-latest scientific journals.

Along with international names reported in these journals, Krishnan also found the name of C.V. Raman and S. Ramanujan. The former had left a lucrative accountant's job to become the Palit Professor of Physics at the University of Calcutta. Students in Madras aspired to work with Raman some day, and one of them, T.K. Chinmayanandam, was already working with him producing some original work in optics. Krishnan found his papers published in *The Physical Review* and the *Proceedings of the Royal Society*.

The biology students who came to the chemistry practical classes, soon came to know about Krishnan's proclivity for Physics and he arranged for a class during tiffin break for students who wanted his help in physics and mathematics. Calamur Mahadevan, later to become a distinguished geologist, was a student of Krishnan. Mahadevan writes:

"I attended lectures that he was giving to Biology group students in the mathematical problems of physics. The voluntary class was always overflowing with students not only from Christian College but from Pachayiappa's and Presidency. I learnt more Physics in Krishnan's class than during the regular lectures, as his explanation of physical concepts was wonderfully lucid."

With the express purpose of working with C.V. Raman, Krishnan reached Calcutta in July 1920. On Raman's advice, he enrolled into the MSc Physics class in the University College of Science where Raman was teaching. Krishnan never appeared for the MSc exam. Although he was a student of the College of Science, his social life revolved around the Indian Association for the Cultivation of Science (IACS) in whose laboratory Raman did his research. In November 1923, Krishnan formally became a research scholar at IACS, and a research associate in 1926. Krishnan calls the first five full years spent at the Science Association under the tutelage of Raman as his *Gurukula vasam*, and recalls, "These five years turned out to be a festive season in my scientific life." In April 1927, with 12 research papers to his credit and a recommendation from Raman, he applied to the University of Madras for a MSc. He was awarded the Master's degree the same year.

Krishnan's first scientific paper titled 'On the molecular scattering of light in liquids' was published in the *Philosophical Magazine*. Krishnan was to author singly or jointly with Raman 16 papers during the years 1925-28,

before the Raman Effect was discovered. In his first research paper, Krishnan essentially repeated his colleague Ramanathan's experiments of 1923. The biography poses the historic question why was the Raman Effect not discovered in 1923 or 1925 and gives various scientific, practical and sociological answers to the poser. When Krishnan took the news of Arthur Compton winning the Nobel Prize in Physics in December 1927 to Raman, the latter was delighted and felt he was closer to India's path-breaking discovery.



K.S. Krishnan with the first flask of liquid helium produced at the Low-temperature Division of NPL, on September 29, 1952.

sunlight as the source. Raman was ecstatic. Between February 19th and 26th, more experiments were conducted by Krishnan. On February 28th, Raman and Krishnan discovered what has now come to be known as the Raman Effect, and the day is now celebrated as the National Science Day. The next day, the news of the discovery was released to the Associated Press. Within a few weeks of Raman's public proclamation of the discovery, Krishnan was able to photograph the "anti-Stokes lines" in benzene and Raman was very pleased. According to Sukumar Sircar, Palit research scholar, who was working on the Kerr Effect in viscous liquids at Science College, Raman felt that discovery of the anti-Stokes lines was as important as the initial discovery of the modified scattering lines at lower frequencies, and he told Sircar that Krishnan deserved half the credit for the discovery and he would share with Krishnan any reward that came to him for it.

But Krishnan knew that although his contribution to the discovery was recognised by Raman and others in the Science Association, in the public eye he was still playing second fiddle. Raman was extremely possessive of the discovery, ever so wary of sharing the real credit of it with anybody else. The fact that Raman had sent the paper titled 'A change of wavelength in light scattering' to *Nature* under his sole authorship without Krishnan's knowledge bothered him. It was known in

February 1928 was the time when Indian science moved towards making history. Under Prof. Raman's guidance, S. Venkateswaran and Krishnan experimented with the new scattering phenomenon in a number of liquids. On the 9th afternoon, when Prof Raman returned from the Science College where he was teaching, Krishnan gave him a visual demonstration of the 'modified scattering' using

the precincts of the Science Association that Raman was in correspondence with some eminent physicists in Europe trying to get the nomination for the 1929 Physics Nobel Prize for himself.

With a view to establishing his own reputation, Krishnan in September 1928 applied to the University of Dacca for the post of Reader in Physics. His application was accompanied by glowing testimonials by his teachers, including Raman. According to the authors, Raman's most generous official praise of his colleague and student Krishnan was in a testimonial to the Andhra University, Waltair, in 1932. It reads as follows: "If the Nobel award for Physics made in 1930 had been based on the record of the year 1928 alone, instead of on the entire work on the scattering of light done at Calcutta from 1921 onwards, Krishnan would in justice have come in for a share of the Prize." This was misleading, as Krishnan started working with Raman in 1923, and a substantial part of the work prior to 1928 was on the scattering of light on liquids.

While in Dacca for the next 12 years, Krishnan's research was in the study of magnetism. In Dacca, he bonded very closely with another South Indian, the Reader in the Mathematics department, T. Vijayaraghavan, and was instrumental in the creation of the Ramanujan Institute of Mathematics of which Vijayaraghavan became first director. A few years later, in December 1933, Krishnan rejoined the Indian Association for the Cultivation of Science in Calcutta as the first MLS Professor, a move to which Raman contributed in no small measure as he himself had moved to Bangalore as the Director of the Indian Institute of Science (IISc). Krishnan's next move was to head the Department of Physics at Allahabad in March 1942. In heading to Allahabad, Krishnan moved closer to the centre of national activity, and in the ensuing years he assumed a leading role in planning the growth of scientific and industrial research of India and also its atomic energy programme.

On June 13, 1946, Krishnan was knighted in an investiture ceremony at Buckingham Palace. In January 1947, Krishnan was back in Allahabad after a rejuvenating tour of Britain and the United States. In June the same year, he moved to Delhi as the first director of the National Physical Laboratory (NPL), hand-picked by Jawaharlal Nehru and C. Rajagopalachari, the head of the Council of Scientific and Industrial Research. Meanwhile, Krishnan's Guru, Sir C.V. Raman, was nearing his retirement at the IISc, Bangalore. When Nehru sent word through Krishnan that the Government was ready to give Raman recurring funds for research in his retirement but asking for an annual report on the progress and expenditure statement in return, Raman is said to have flown into a rage over the strings attached.

The NPL was formally inaugurated at its Hillside Road (now Dr. K.S. Krishnan Marg) location on January 21, 1950. Deputy Prime Minister, Sardar Vallabhbhai Patel was the chief guest. To help Patel, who had difficulty in walking, to inaugurate the laboratory from the dais, Krishnan built a wooden replica of the building and placed it on the dais. The snapping of a ribbon and an electrical wire, tied around the building, was to activate a switch which was connected to a transmitter that sent a signal to be picked up by a receiver placed inside a building. The receiver actuated in turn a relay circuit that switched on electric motors which would force the main doors open.

Krishnan lived his life to the fullest. He pursued his interests in Physics till even a few hours before his death on June 14, 1961. His last paper – finalised on the day of his death – came out a month after his death