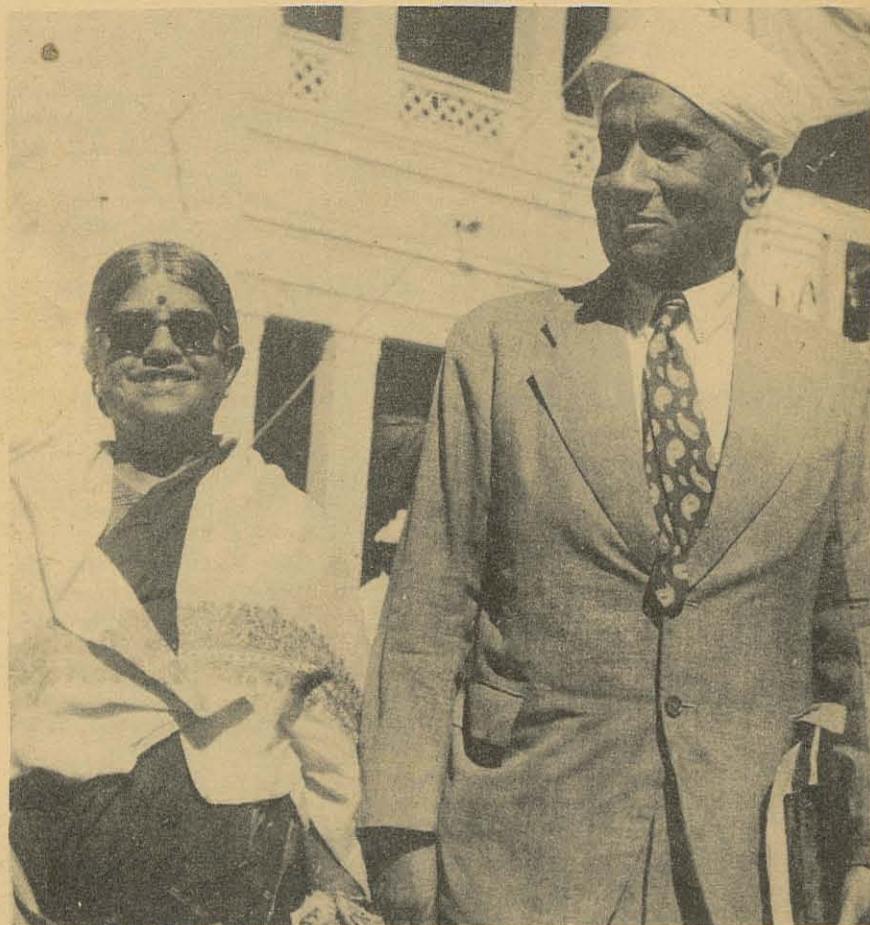


RAMAN SAGA



Dr. C. V. Raman and Smt. Lokasundari Raman.

The Bhagavadgita narrates in detail the divine manifestations or vibhūtis and singles out the great ones in each field of human accomplishment. Sir C. V. Raman was a dedicated scientist and if one could take the liberty of enlarging the list, we may include him. He was a scientist with a vision and one who followed it with a singleness of devotion and dedication living true to those words of the Gita:

*Whatever there is in this world that is great and good,
That, O Arjuna, you regard as emanating from an amsha of Mine.*

—Ed.

An Illustrious Son of Noble Parents

A SANSKRIT epigram says:

पुत्रादिच्छेत् पराजयम् *putraadicchet paraajayam*; and it means that a parent should willingly accept defeat from his son. Dr. Sir C. V. Raman indeed excelled his parents, thus bringing delight to them.

Dr. Sir C. V. Raman was born of Sri Chandrasekhara Iyer and Smt. Parvati Ammal. The parents belonged to two well-known Brahmin families of Tamil Nadu. Raman was born on the 7th November in the year 1888, at Ayyanpettai near Tiruchirappalli in the then Madras State. The family had been for many generations pursuing the profession of the agriculturists and they were middle-class in status. In fact, the first to take a bold step and break off from the ancestral profession was Raman's father, who became a teacher in a High School, then rose to the position, after duly qualifying himself, of a Lecturer and ultimately the Professor of Physics in the Hindu College, Vishakhapatnam. Rather, he came back to the ordained profession of the brahmin, giving up the Apaddharma of his ancestors.

Raman's father, Sri Chandrasekhara

Iyer, was more than a mere student of Science. He had a keen aesthetic sense and cultivated this by playing well on the Veena and the Violin, often surprising and delighting his colleagues with concerts on them whenever he could snatch a couple of hours from his round of busy academic duties.

Raman's mother, Parvati Ammal, hailed from a family renowned for Sanskrit scholarship. It is said of the father of Parvati Ammal that he trekked all the way from Tiruchirappalli to Nadia, the famous seat of *Navya Nyaya* or modern Indian Logic, where the greatest intellectuals like Gadhadhara lived and propagated their school of logic, in order to learn Logic, and returned also on foot. Parvati Ammal possessed in an unusual degree the qualities of patience, self-reliance and perseverance and would never content with the run-o'-the mill in life. She was a stickler for details and would never let things drift and happen for themselves.

Of such parentage came Raman, naturally inheriting the best of two great families that had been brought together by a sacred marital arrangement, by a *Brahmi vivaha*, which

was intended to bring forth a worthy son that would hold the torch of knowledge aloft. The life and achievements of Raman are an unmistakable commentary and elucidation of these.

No wonder, Raman inherited the best from his parents and in the process excelled both.

Educational Career

At Visakhapatnam, Raman studied at the Hindu College High School and had the distinction of being a first-ranker throughout. Right from the middle-school stage, science was his first love. It is said, in those days, Raman designed a prototype of a dynamo, starting literally from scratch.

In quest of more knowledge, Raman started reading voraciously, specialised literature on heat, sound and electricity. The ten-year-old would hire books from B.A. students and would be lost in them for hours. This unceasing effort told on Raman's health. One day, the bed-ridden youngster was so much enamoured by the Leyden Jar experiment that he would not go to sleep. His father had to demonstrate the experiment by the bed to save Raman from insomnia.

Prolonged ailments prevented his regular attendance at school. Nevertheless, Raman stood first class first in the matriculation examination, when hardly 12 years.

He passed Intermediate (1902) from the Hindu College, and joined Presidency College, Madras, for B.A. (Physics). His relatives impressed upon him that he should take history or economics as special subject, but Raman would not budge. He had

made up his mind to opt for physics; and in 1904, he passed out as No. 1 of the University, bagging a host of medals, prominent among them the Elphinstone Medal and the Arni Jagirdar Memorial Gold Medal.

Continuing his post-graduate studies in physics, Raman received V.I.P. treatment at the hands of fellow-students as also teachers. Not for him any imposition of regular attendance; not for him any restriction at reference libraries.

Raman, the Researcher in the making: "Coming events cast their shadows before them".

A little incident these days served as an eye-opener to what was in store for the immediate future. While engaged in a prism experiment one day, he was struck by a peculiar phenomenon. His inquiring mind would not rest without finding an explanation. Late into the night, Raman probed into all relevant literature, but the answer still eluded him.

Next morning, he repeated the experiment—and gave his own theory to the 'unusual'. Later in the day, he submitted the thesis to Physics Professor Jones. Months elapsed, still there was no comment from the Professor.

A restless Raman later approached Jones with a suggestion: "May I enlarge the theory, in the light of freshly-attained knowledge on the subject?" Collecting the papers from the Professor, Raman published them in a British science journal. Still apprehensive, he showed his master the publication—his maiden effort at writing—only to receive a bear-hug

from the Guru.

The response was impulsive; it served as a shot in the arm for Raman, the writer. Soon, he was confronted with a ticklish problem by his colleague, Appa Rau. Raman thought about it and the result was another article on a new facet of light in *The Philosophical Magazine*, of London, in 1906. Raman was just about 18 then. A third article was published in 1907, in *The Nature* bringing fresh accolades to the writer.

In January 1907, Raman secured a first class in M.A. (Physics)—first in the history of Madras University—and was all set to go to the U.K. for advanced studies. But his poor physique proved a stumbling block.

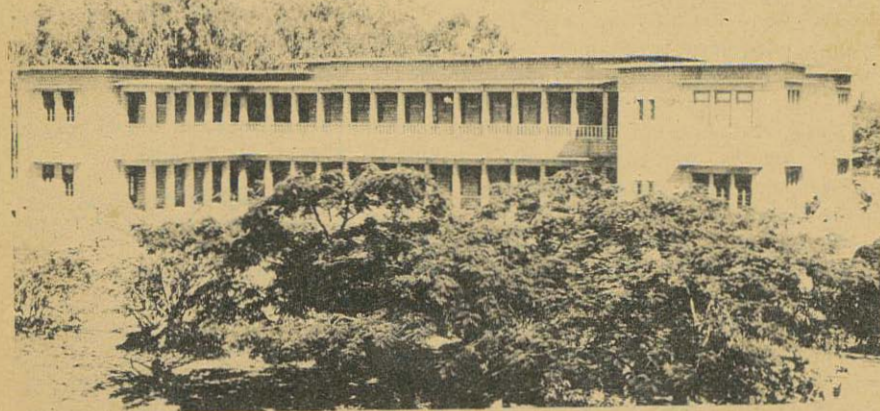
The Physicist in Hybernation

For a moment it looked as though the physicist's career was all over,

barring the "Good Bye". Pestered by friends and relatives, Raman at last appeared for a competitive examination at Calcutta in February 1907. The subjects—history and economics—were Greek to him, yet he came out first of the lot.

While still awaiting his posting, Raman got married to Loka Sundari, setting a revolutionary precedent to inter-sect marriages in the Brahmin community. The hard core of the orthodox relatives blacklisted Raman for this unbecoming conduct, but the progressives were with him. The intelligent, loving Raman looked "ideal" for Loka Sundari (literal meaning: world's most beautiful maiden), whose proficiency in music and fine arts and individualistic charm were very much liked by the bridegroom. The marriage of talents later proved very effective: Raman scaled

Front view of Raman's Research Institute;



new heights in the theory of musical notes, thanks to his wife's knowledge of music, vocal and instrumental.

In June 1907, Raman was appointed Dy. Accountant-General, in Calcutta. A good monthly salary, a loving wife, a well-furnished house, prospects galore in days to come—all these would have made a white-collar happy and contented. But Raman's yearning was still for science. Physics had become a part of him; he could not go far away from it.

One fine evening, while returning home from office work, Raman was surprised by a banner on a sidewalk: "The Indian Association for the Cultivation of Science". Jumping out of the running tram impulsively, Raman made his way to the dilapidated building.

A conference was on; Raman lost no time in getting acquainted with all the scientists present. The Association's Secretary, Amrit Lal Sarcar, son of Mahender Lal Sarcar who founded the Association in 1876, and Sir Asutosh Mookerjee, an active member of the Association, were highly impressed by Raman's works. Thus started anew another chapter in the physicist's career.

In 1910, Raman was transferred to Rangoon, bringing in its train a science holiday for him. While in Burma, news of a distant institution having bought a modern scientific instrument reached Raman. Past midnight, Raman reached the spot, shook up a snoring watchman, went with him to the Superintendent's residence and glanced gleefully at the apparatus, hours before dawn next day.

Months later, Raman's father ex-

pired. Having completed the religious rites for the departed soul, he spent the remainder of his leave in pursuit of research at Presidency College, Madras. This served only as a short refresher, for Raman was soon posted to Nagpur, where, again, there was no scope or facility for doing research.

The human transcending the limits of officialdom

There is a little fable still being recalled by a Nagpur villager whose collection of hundred-rupee notes were nearly burned by a blazing fire. The forelorn tribal made to the A-G's office with scant hope. "Any other officer would have shown me the door. But this *sahab* scrutinised the notes, one by one, under a magnifying glass and instructed the treasurer 'Give him fresh notes. Numbers are visible alright. It's a case.'" The meticulous scientist held the key to the poor man's new life!

In 1911, Raman was deputed on promotion to Posts and Telegraphs, as Special A-G, to Calcutta. Time was when Sir Asutosh Mookerjee, as Vice-Chancellor of the Calcutta University, had just founded the University Science College, with the help of donations from Sir Rash Bihari Ghosh and Sir Taraka Nath Palit.

From the hibernating moth in the cocoon to the state of a many-splendoured Butterfly

Sir Taraka Nath had earmarked part of his donation for appointing a distinguished Physics Professor. Raman was Asutosh's natural choice and Raman's choice was physics, of course. In 1917, with scant regard to



Dr. C. V. Raman receiving citation from Czech Envoy, an honour from the Czechoslovak Science Academy.

the monetary handicap in accepting the literary assignment, Raman bid "Good Bye" to administration and joined the Calcutta University as "Palit" Physics Professor.

In what Raman himself confesses was his Golden Era in scientific research, the ace physicist made substantial contributions, the most important being the *Raman Effect*, which brought him Nobel honours.

In 1919, following the death of Amrit Lal Sarcar, Raman was elected Secretary of the Indian Association for the Cultivation of Science. Two years later, he represented Calcutta at an All-British-Empire Universities Congress. In 1922, Raman was awarded D.Sc. by the Calcutta University.

In 1924, he was a guest speaker at a Scientists' Convention in Canada. Making good of the visit, Raman extensively toured Canada, the United States, England and Norway. While in America, he called on Nobel Laureate Millican, at whose instance Raman served as a Visiting Professor, for four months, at the California Institute of Technology.

The Royal Society of London awarded him a Fellowship in 1924. The same year, he founded the Indian Science Congress. For years together, he worked as its Secretary and also presided over the 1929 Madras Convention.

In 1925, at the second centenary of the Russian Science Academy, Raman represented India. The return

trip from Moscow gave him a chance to study firsthand the progress made by Germany, Switzerland and Italy in the sphere of Physics.

The year 1926 saw Raman publishing the *Indian Journal for Physics*. About this time, the German Physical Society made him a special request to contribute an exclusive article on musical instruments for its *Handbook of Physics*. In response, Raman dwelt on musical instruments, in general, laying a pointed stress on Veena, Mridangam and a host of Indian instruments.

The long years of his research work on light culminated in the discovery of the *Raman Effect* in 1928. In 1930, the Nobel Prize for Physics was awarded to him—the first ever Asian to win this supreme honour.

The truly Indian tenor in Raman—"In it but yet above it"

At the prize-awarding ceremony in Stockholm, Raman demonstrated the "Effect", using a number of liquids, one of them alcohol. The dusk drew near and the stage was set for a grand cocktail reception to the Nobel Laureate. "This morning, Raman demonstrated his Effect on alcohol. Now we would see the alcohol's effect on Raman" an invitee cracked pushing a glass in Raman's direction. The reaction was not reversible, the effect was not reciprocal. With a modest "Thanks", the glass was returned, for Raman was a teetotaler.

The Golden Era

The Golden Era paved the way to one better in 1932. After 15 years'

service with the Calcutta University Science College, he decided to go south, accepting a Directorship at the Indian Institute of Science, Bangalore. Raman was instrumental in fetching due importance to fundamental research, mathematics and physics, at the Institute.

The unceasing enthusiasm of Raman brought fresh honours to the Institute. In 1934, the Indian Academy of Sciences started functioning and 1948 saw the emergence of the Raman Research Institute.

Following the establishment of the Raman Research Institute, Raman resigned the Directorship of the Indian Institute of Science in favour of that of the Raman Research Institute. As Director of Raman Research Institute, he has been able to realise his dream of a live-wire organisation devoted might and main for the advancement of the many facets of physics. The institute has also sections devoted to meteorology, bio-chemistry and mathematics, and has a fullfledged observatory. It also publishes a periodical, *Proceedings of the Indian Academy of Sciences*.

Almost every leading Indian physicist has had his association with Raman. The man who ushered our country in the Atom Era, Dr. Homi Bhabha, and the one who now carries the torch, Dr. Vikram Sarabhai, are but two of his illustrious disciples.

Following the advent of political freedom, India launched an adventurous plan to boost her scientific skills. A scheme was drafted to award National Research Professorships to enable native geniuses give new meanings to their knowledge, through aid

Dr. Raman was a great teacher. His knowledge was not confined to physical science. In this overspecialised world his breadth of knowledge was remarkable. He combined highest intellectual integrity with a winning warmth of heart. His latter feature sometimes comes out in his utterances which are delightfully free and frank. He was our most illustrious scientist, who continued for many years to guide the scientific progress of India.

—Dr. S. Radhakrishnan

with no strings attached. The first National Research Professorship was awarded to Raman—it gave the scientist Rs. 2,500 a month, for research on any subject of his liking.

The medals and honours Raman has received in the past add up to an impressive array. In 1928, he was given the Matuchi Medal by the Italian Science Council; in 1929, he was knighted by Emperor George V; in 1930, The Royal Society of London awarded him the Hues Medal; the same year, the Freeburgh University honoured him with a Ph.D. and the Glasgow University with an LL.D.; and in 1932, the Paris University gave him an Sc.D. The University of Bombay, Madras, Benaras and Dacca have also honoured him with Doctorates.

Raman is a member of many international scientific organisations. The

SCIENTISTS SHOULD FACE CHALLENGE OF TIME

In India, the scientists often did not get the equipment or freedom they needed. But, instead of being discouraged by it, they should regard it as a challenge.

Some of the great discoveries of the world had been made in not-so-well-equipped laboratories. The challenge would be all the greater in India due to various factors.

The expenditure on scientific research and development had gone up five times. The number of science personnel had gone up four times. Scientific research had expanded into many areas. But, in spite of this expansion, India had not secured sufficient returns from the quantitative expansion of scientific research and education, as it was not using its considerable potential to the fullest.

It was rather disturbing to find that the leaders of the scientific community, who should guide the Government in identifying the imbalances to be corrected and initiatives to be taken, themselves looked towards the Governmental bodies most of the time.

We have to formulate a series of research and development programmes which are related to specific socio-economic goals and which are integrated financially and institutionally into an overall policy.

—Smt. Indira Gandhi, Prime Minister of India, inaugurating the Conference of Scientists and Technologists at New Delhi, Nov. 28, 1970.

German Academy, Munich, the Physical Society, Zurich, the Royal Philosophical Society, Glasgow, the Royal

Academy of Ireland, the Science Academy of Hungary, and the Academy of Sciences, Paris, are but a few of them.

He was Chairman of the Indian Academy of Sciences, since its inception in 1934.

In 1951, the Philadelphia Institute of America awarded the Franklin Medal to Raman. In 1954, the top-most honour to an Indian from the Government of India—*Bharat Ratna*—went to him. The Soviet Union honoured him with the International Lenin Prize, in 1957.

Despite the glimmer of gold medals and honours that came his way from all quarters of the world, Raman was his own humble self. Evidently, the lure of lucre too had no effect on Raman.

What Raman means to the common man

It is somewhat difficult for the uninitiated common man to understand the work and achievements of a great scientist. The theoretical part of the *Raman Effect* may be beyond his ken; but he will certainly be in a position to appreciate the impact such a theory has had on his own life. *Raman Effect* and the instruments that were developed based on this theory, such as the Raman Spectroscope, the electron microscope and the ultra-centrifuge, have made it possible for the development of a host of synthetic products. The artificial molecules which the scientists have been able to synthesise are vital to science and industry. Plastics, synthetic rubber and colour photography—all these owe their origin and development to this discovery.

The diamond does not go in search of a person but it is tenaciously sought, says one of the Sanskrit stanzas. Raman was interested in diamonds, not as one who was enamoured of its market value but as it happened to be the most extraordinary sample of matter in the solid state. Actually, he spent a considerable sum from his Nobel Prize money to buy some 300 diamonds. As his researches made headway, diamonds from the Kimberley mines did come in search of him.

A new theory of his envisages the lights of the future as crystals bombarded by ultra-violet rays and with this new invention the neon lights would be things of the past. Another interesting discovery of his was to show that the so-called heat in liquids was only the interplay of high frequency sound waves. He also demonstrated that in crystalline solids sound waves of very high frequency measured in millions and millions of vibrations per second were found. A normal musical note has a frequency of some 2 to 5 hundred vibrations per second but high frequencies like this become inaudible.

Raman naturally was led on to investigate the subject of vision as he was very much concerned with light and its effects. He has devised a simple means by which we can look at our own retina and see what goes on there; a real turning of the man's eye inward indeed!

Like all other great scientists, he was also upset by the horrors of war and the scientist's dilemma in this affair. For, it was the fate of every

scientist to observe with concern and often with a sense of utter helplessness that his theories were put to destructive uses by a political group that had power.

That he loathed this and that he did not like the politicians to dabble with science in this manner is clear from many of his pronouncements and actions. His refusal to participate in the Science Congress whenever politicians usurped the position of Chairmen or Presidents is a clear proof of this.

Raman was great as a scientist; the initiated student of science alone can have a glimpse of the towering intellectual power in this prodigy. But ever and above this was the man, the human being that was Raman. Though he was loth to indulge in flattering

praise and equally quick to criticise what he felt were undesirable things, he was a great lover of mankind. An incident is narrated of his dealings with an applicant that came for a post in his Research Institute. The man was found unsuitable from the interview and tests. He was sent away with the travelling allowance that was due to him. The person lingered a little while, checked the cash paid to him by the office and found that they had paid him more. He was returning to the Clerk that he may pay back the excess when he was noticed by Raman. Not knowing why the young man was lingering there, he sharply remarked: "I told you, we cannot take you in. Why do you linger here?" The applicant answered: "I know that,



Dr. Radhakrishna, the son of Dr. Raman lighting the pyre.



The funeral bier brought for cremation.

Sir, but I came back that I might return the excess cash paid to me by mistake by your office." It is said that Raman took him in with the re-

mark: "Come in, you have been accepted. It matters not if your physique is inadequate, I can teach you that. You are a man of character!"