SIR C. V. RAMAN

Our Inspiration

a tribute from

THE OFFICE OF THE ACCOUNTANT GENERAL(A&E) WEST BENGAL.

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TREASURY BUILDINGS, KOLKATA-700 001

PREFACE

The fact of Sir C.V.Raman having been part of our service has been passed down to generations of IA&AS Officers as a folklore. The knowledge of this fact obviously fills all of us in IA&AD with pride as well as hope. This knowledge also whetted our desire to know some more about Sir Raman's association with the service and the department.

While we all have always taken pride in being part of the institution which gave to the country a lone homegrown noble laureate in the field of Science, our lack of definitive awareness about Sir Raman has quite often been embarrassing.

Sir Raman had worked as Assistant Accountant General in the Office of the erstwhile Accountant General (Bengal) which was housed in Treasury Buildings at Kolkata where presently Office of the Accountant General(A&E), West Bengal is located.

Need was felt to bring out a small booklet on the life of Sir Raman. Undoubtedly Sir Raman is the highest achiever in the history of IA&AD and reading or knowing about him is always going to be highly inspiring. Making a discovery worth a noble prize has got to be on the foundation of unflinching devotion. We would be doing great justice to our association with Sir Raman if we draw inspiration and could even put one tenth of that devotion and achieve excellence in whatever we do.

Sir Raman had carried out his research work at IACS complex at Bow Bazar and it was heartening that IACS had highly meticulously preserved memories of Sir C.V.Raman. Sir Raman's bust is installed in the present premises of the Institute at Jadavpur. The Association has also preserved the spectrograph which Sir Raman used for research work that culminated into the discovery of the famous RAMAN EFFECT which earned Sir Raman the Noble Prize in 1930.

The Calcutta Municipal Corporation had organized a Civic Reception for Sir Raman on his receiving the Noble Prize in 1930 and brought out a gazette publication on the occasion.

Sir Raman had also served at Rangoon and Nagpur while he was with the department.

The present work does not claim any originality. We have picked up facts from various books and publications and collated the same according to the format we felt would suffice for our purpose.

I am thankful to IACS and CMC for their cooperation. We acknowledge our indebtedness to the various sources from where we have borrowed unabashedly but for a cause of providing inspiration to ourselves.

This booklet is a result of untiring efforts of Sri Shourjo Chatterjee Assistant Accountant General who worked for this cause with utmost sense of commitment. I also like to thank Shri Malay Basu, our in-house photographer who did the photography.

This booklet is our tribute to the excellence achieved by our most illustrious service-predecessor Sir C.V.Raman. I hope and trust all of us would draw inspiration from Sir Raman's life.

Date : 17.11.2004.

NAND KISHORE

Accountant General (A&E), W.B.

Acknowledgement

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I. The Early Years – Education and Upbringing

On the 7th day of November' 1888, Shri Chandrasekhara Ayyar and his wife Smt. Parvathi Ammal were blessed with their second son. The boy took his first steps in his ancestral home in the town of Tiruchirapalli on the banks of river Cauvery in the present day Indian State of Tamil Nadu. The Ayyars named their son, Venkata Raman. Keeping in tune with the South Indian tradition of affixing the father's name before one's name, he became Chandrasekhara Venkata Raman. He went on to become one of the greatest sons of India and became world famous as Sir C. V. Raman.

Chandrasekhara Ayyar and family. Raman extreme left.

Sir Raman's family had for generations lived by agriculture. Yet they were always striving to inculcate the modern values of Science and Education. Sir Raman's father, Shri Chandrasekhara Ayyar attended school in the town of Kumbakonam and passed the Matriculation examination in 1881. He also completed his Intermediate from the Society for Promotion of the Gospel College (SPG) Tiruchirapalli. He enrolled for Bachelor of Arts at the Madras Christian College, but was unable to complete his studies. He worked as a school teacher for a number of years. However, the drive towards completing his education made him to go back to the SPG College and obtain the BA degree in Physics in 1891. Thereafter, he became a lecturer in the Mrs. A.V. Narasimha Rao (AVN) College, Visakhapatnam. Sir Raman's mother was the daughter of a renowned Sanskrit Scholar Shri Saptarshi Sastri who had travelled on foot to the then distant Bengal (over 2000 km away) to learn Modern Logic.

These traits of perseverance and desire for modern learning percolated down to the young Raman. At the time of Raman's birth, his father's salary was a princely amount of Rupees Ten. Later in his life Raman had jokingly remarked that he was born "with a copper spoon in my mouth". But he inherited priceless assets in the form of inclination towards scholarship in general and Mathematics and Science in particular from his father.

On the cultural side, Raman's father loved music. This was to some extent natural, since the Tanjore region where he hailed from, is like a cradle of music. He played the Violin well. Raman also inherited this interest in music. Apart from being proficient in playing a number of Musical Instruments like the Violin and the Piano, a substantial amount of his future research efforts were directed towards the acoustics of a wide variety of Musical Instruments.

Education

Raman had his early education in a high school at Visakhapatnam. At an early age of eleven, he stood first in the matriculation examination. He displayed brilliance at every stage and won several awards and scholarships at the young age. Raman was fortunate to have a big library in his house that was maintained by his father. At a young age, he mastered the 19th Century's most popular science textbook called 'Ganot's Physics'. He used to conduct sundry experiments using the materials available at home. To say the least, he was passionate about Science. Once he built an electric dynamo from scratch. As a child, one of his tantrums was the refusal to go to bed until his father demonstrated the functioning of a fascinating electrical equipment called the 'Leyden Jar' to him. After passing the matriculation examination, Raman joined the Mrs. AVN College to study for the intermediate. Apart from Raman's father, Shri P. T. Srinivas Iyenger, a versatile scholar and the then Principal of Mrs. A.V.N College made a great impact on young Raman. Although Raman was fond of Science, Scientific Experimenting and

Raman as College Student.

Handicrafts like carpentry, he had a marked distaste for subjects like History and Sanskrit. However, Raman had a fascination for English. He picked up the language along with the finer points at a very young age.

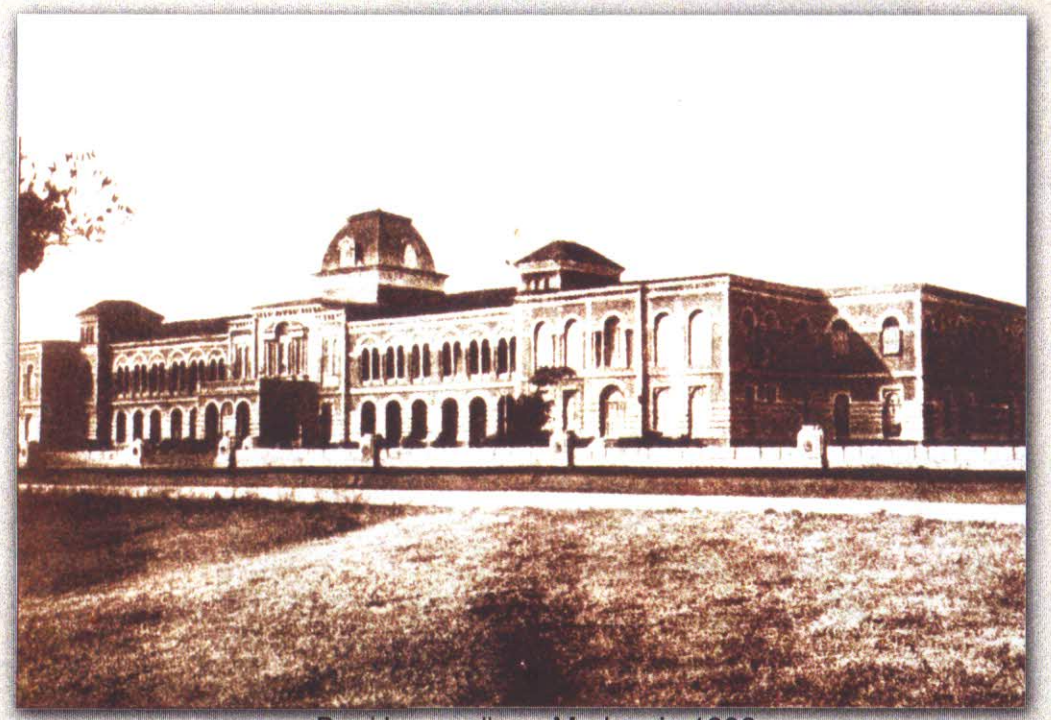
Raman cleared the Intermediate Examination at the age of 13, won a scholarship and joined the Presidency College, Madras.

"A good home and a good school may be judged by the kind of books they put in the way of the growing young person for him to feed his mind and emotions upon".

-Raman

II. The Youthful days – Diverse Interests.

At a young age of thirteen, Raman entered the portals of the prestigious Presidency College, Madras to pursue his B. A. At that time Raman was a thin unimpressive boy, with a dhoti, a cap and no chappals on his feet. A story goes that one of his professors, Prof. E. L. Eliott could not believe that Raman was a student of that College. Raman's experiences over the four years that he spent at Presidency were quite pleasant. He was especially appreciative of the extra-ordinary kindness and consideration that he received from the European members of the staff, who were then the heads of the departments of study



Presidency college, Madras in 1906.

However, the professors soon came to know of Raman's intelligence and went to the extent of exempting him from the classes thinking that he had nothing to learn from them. Raman was praised lavishly by his professors, to the extent of being hailed as the best student in thirty years. Apart from Raman's brilliant scientific disposition, his excellent command over English also attracted attention. He was awarded the Elphinstone Prize for English Essay.

In fact, Raman's liking for English was stimulated by the English classes. Apart from the actual classes, Raman was also highly fascinated by the general setting of the English Classes which were conducted in a lecture hall overlooking the sea, with the beauty of the waves beating against the beach.

Marina Beach, Madras.

Raman's personality was shaped during his youth by various books to which he got exposure. Raman himself said that he got immense help from the multitude of books that he came across till he was eighteen and completed his school, college and university career. He said that in the narrow sense he became tolerably familiar with subjects as diverse as Ancient Greek, Roman History, Modern Indian and European History, Formal Logic, Economics, Monetary Theory and Public Finance, Physiography, Chemistry, four languages, a dozen branches of Pure and Applied Mathematics and Experimental and Theoretical Physics. Out of this multitude of books, Raman mentions three which helped in moulding his mental and spiritual outlook and determining the chosen path in life. Edwin Arnold's 'The Light of Asia' helped him in cultivating an abstract idealism or belief in the value of human spirit and achievement.

Raman was especially moved by the story of Siddhartha's great renunciation, of his search of truth and final enlightenment. The impression on Raman was so strong that later in life, he made frequent references to the Buddha, including during the dinner, which followed the Nobel Prize ceremony.

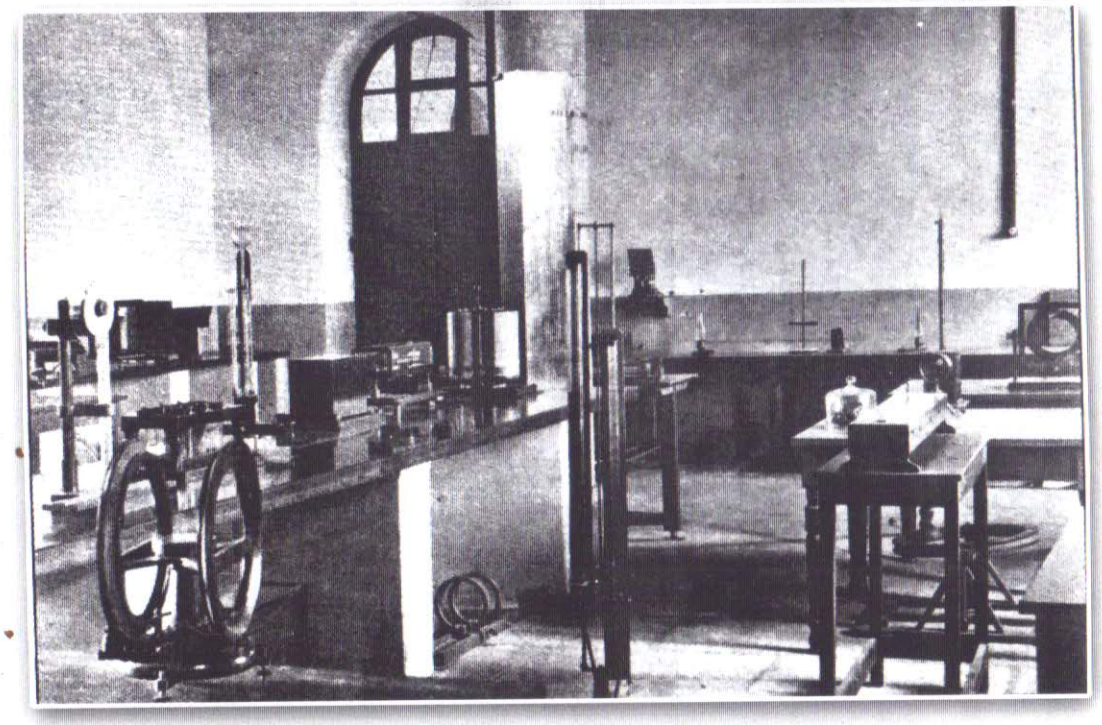
Sir Raman was also greatly influenced by the set of books 'The Elements of Euclid'. He said that his own early reaction to the compulsory study of Euclid was not favorable. This was because of the undue stress on the properties of the constituents of Geometry, rather than a focus on the subject as an integrated whole. Raman said that of all the branches of Mathematics, Geometry helps in linking what one views and what one links through reasoning.With the help of Euclid, Raman finally appreciated the central position of Geometry in relation to all natural knowledge. Raman also developed a keen interest in crystals and gems.

Raman had inherited an intense love for music. However, he did not sit back and enjoy the soothing effects of music. The works of Hermann Von Helmholtz prompted him to conduct studies on the physics of Musical Instruments. He was especially influenced by an English translation of Helmholtz' 'The Sensations of Tone'. Raman said that he discovered this book and read it with the keenest interest and attention. He said that this book helped him in understanding the real meaning of scientific research and how it is to be undertaken. Raman was also influenced by Lord Rayleigh's works which heavily influenced his works on optics.

In January' 1904, Raman passed his BA Examination by topping the list and winning gold medals in English and Physics. His teachers advised him to go to England for further studies. But the Civil Surgeon of Madras ruled it out on health grounds. Later in his life, Raman said that he would remain forever grateful to the surgeon for advising him against going to England.

Raman enrolled in the MA class in the Presidency college to study Physics under Prof. R Llewellyn Jones. Under him, Raman enjoyed an unbelievable amount of academic freedom to the extent that during the two years of M.A., Raman attended just one lecture. Prof. Jones' greatest contribution to Raman's life and career was this academic freedom which spurred Raman to diversify his research oriented faculties.

Raman topped the MA Examination in January' 1907. Raman's mind and heart were both in Science. But scientific research as a career in India during those days was not a feasible option. Government Service was the only other practical and secure career option. The Indian Civil Service was the highest echelon, but even for that, one had to study and appear in the exam in England. But going to England had already been ruled out in Raman's case.



The Physics Laboratory at Presidency college.

However, the examination for selection in the Financial Civil Service (FCS), which was the fore runner of today's Indian Audit and Accounts Service, (IA&AS) was conducted in India. Raman's elder brother C. S. Iyer was also a member of this coveted service. Although Raman had to study unfamiliar subjects like History and Economics, he still managed to secure the top position in the FCS examination, held in February, 1907.

Raman and Lokasundari

Raman dared to be different on his personal front. Raman became friendly with Mr. Ramaswamy Sivan during his studies at the Presidency college. Raman used to frequently visit Sivan's place. Raman fell in love with Sivan's thirteen year old sister-in-law, Lokasundari, after listening to her play the Veena, a stringed musical instrument. Although Raman and Lokasundari belonged to different sub-sects, they got married, despite the displeasure of many in the family, including Raman's mother.Lokasundari remained Raman's backbone for over six decades, although she was never sure whether Raman married her for the Rs. 150 marriage allowance which the Finance Department gave to its married officers.

Soon after his marriage, Sir Raman got his first posting at Calcutta in 1907 and thereafter began his long standing association with the city of joy.

"The history of science has shown that real fundamental progress is always due to those who had ignored the boundaries of science as a whole."

-Raman

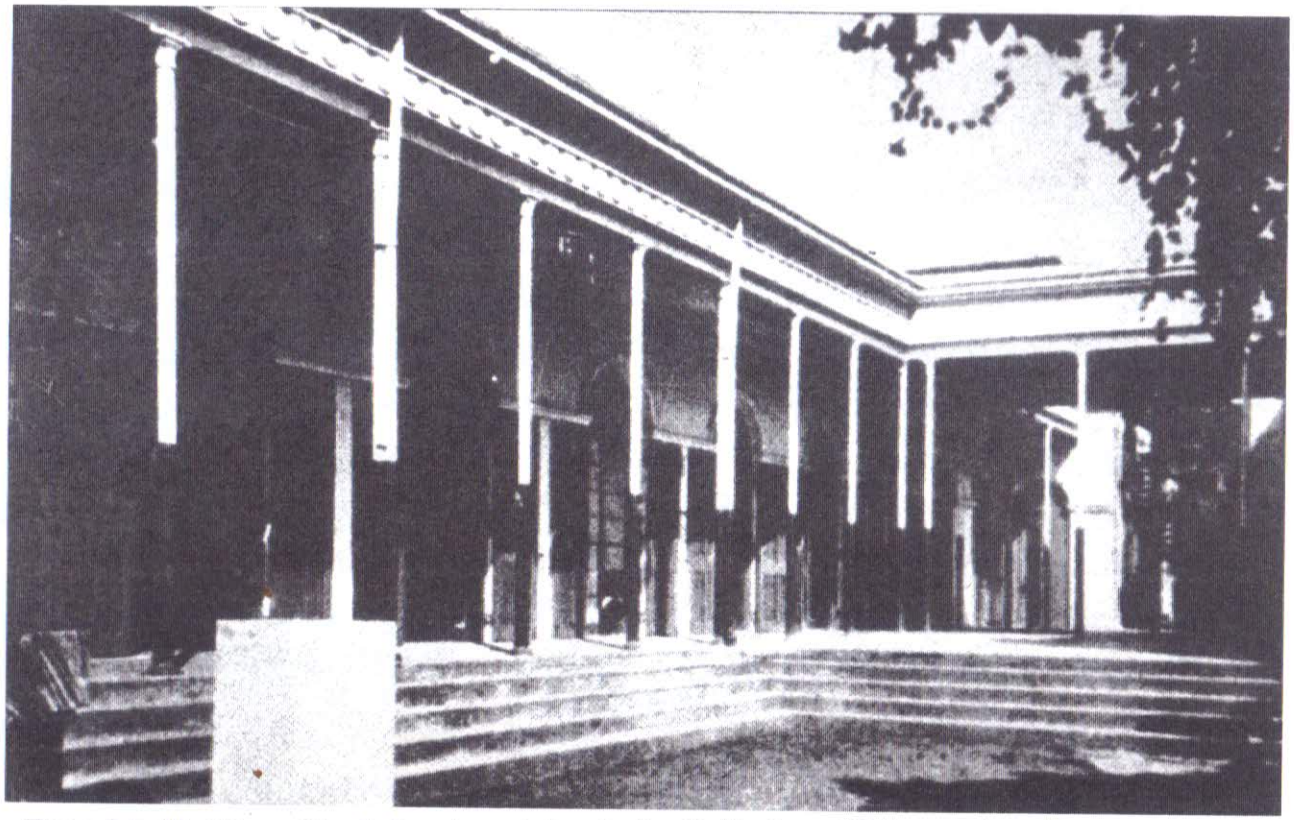
III. Early days in Calcutta – The Officer Scientist.

In June 1907, Raman was posted in the office of the Accountant General, Bengal in Calcutta as an Assistant Accountant General. Although he entered Government Service rather than pursuing a full-time scientific career, it turned out to be a real blessing in disguise. With the government service, Raman's financial worries were taken care of. He got a monthly salary of Rs. 400 including Rs. 150 as marriage allowance. He was able to focus on his scientific pursuits in his free time, without any worry on the financial front. Raman was doubly fortunate to get his first posting in Calcutta the then capital of British India. Calcutta offered him scientific opportunities, which no other city would have in those days.

Sir Raman rented a house in Scots Lane off Bowbazar Street (now Bepin Behari Ganguly Street). He used to traverse to and from the Treasury Buildings, daily in a tramcar. On his way to work, he had noticed a signboard reading "Indian Association for the Cultivation of Science" at 210 – Bowbazar Street. Shri Ashutosh Dey greeted Raman at the Association. Also known as Ashu Babu, Ashutosh Dey remained steadfastly with Raman as his assistant for the next twenty-five years.

Raman in 1907 as Assistant Accountant General

The Indian Association for the Cultivation of Science had come into a concretized existence in the last quarter of the Nineteenth Century. Its founder was Dr. Mahendra Lal Sircar who wrote an article titled 'On the Desirability of a National Institution for the Cultivation of Sciences by the Natives of India' in the August 1869 issue of the Calcutta Journal of Medicine. This served as a preamble to the Indian Association for the Cultivation of Science.



The original building of the Indian Association for the Cultivation of Science where Raman worked.

When Raman arrived in Calcutta, P. C. Ray and J. C. Bose were the two stalwarts conducting original research at that time in individual capacity. However, very little organized research work was being carried out. Raman's desire of using the Association premises for research purposes found instant favour with Dr. Amrita Lal Sircar, the nephew of Dr. Mahendra Lal Sircar and the then honorary Secretary of the Association. Raman got himself enrolled as a member of the Association and obtained permission for carrying out research in his spare time. In a short period, a large number of research papers of his were published in many leading journals of international repute. Raman was able to attract research workers from rest of the country to the Association.

By 1917, due to the research work and efforts of Raman and his contemporaries a Calcutta School of Physics came into existence and the dream of Dr. Mahendra Lal Sircar was realised. Amrita Lal Sircar handed over the keys of the premises to Raman, who from thereon efficiently proceeded towards the fulfilment of his scientific endeavour.

Inside View of Treasury Buildings.

Young Raman was equally faithful to his service and science. This can be gauged from Raman's daily schedule described by his young wife. Early in the morning at 5.30 AM, Raman would go to the Association and from there he used to return at 9.45 AM. After a quick bath and meal, he would leave for the Treasury Buildings, invariably by taxi, so as to be there on time. After office at 5.00 PM, he would go directly to the Association. He would return home by 9.30 or 10.00 PM. On Sundays and other holidays, the whole day used to be spent at the Association.

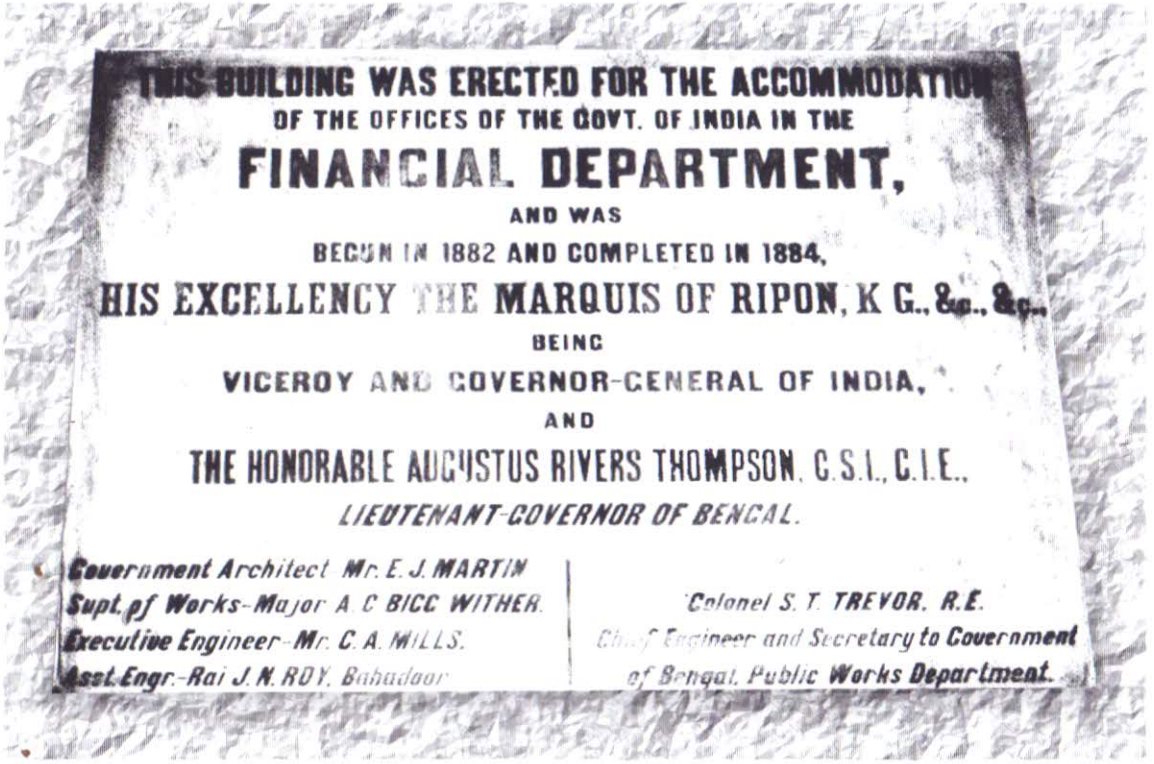
Site at which the Indian Association for the Cultivation of Science stood.

Raman's contribution to Science even during his early days in Calcutta was immense. He and Ashu Babu used to be the only researchers during his early days at the Indian Association. And thanks to them, the Association began churning out numerous scientific publications. Raman started the Bulletin of the Indian Association wherein he published major monographs. In 1917 the Bulletin became the proceedings of the Indian Association and much later became the Indian Journal of Physics.

At the thirteenth annual meeting of the Indian Association held on November 21st 1907, Dr. Amrita Lal Sircar after presenting the annual report for the year 1906, informed the house about Raman's commencement of research work at the association with wholesome praise for Raman and a great sense of satisfaction for the association having got a "young student with fine intellect who has been doing research work in our laboratory on physical optics. A side issue of his work has been published in the 'Nature' of the 24th October' 1907. This young student, Mr. C. V. Raman, who has also become our member is now in the Finance Department for his livelihood and what an amount of energy is lost there. If you, my countrymen, could provide for such intellects then what a rich harvest would you have reaped from them. If circumstances do not go against us, Mr. Raman will prove to be the brightest ornament of this Association". Dr. Sircar compared the discovery of Raman by the Association to that of the discovery of Davy and Faraday as Scientific talents.

Dr. Sircar was right in every aspect of his comment except that Raman's energy was being lost in the Finance Department.

Although, at heart Raman was a Scientist, the Officer in him that earned his livelihood was no less efficient. He was congratulated many times by his "superiors" for his outstanding work. The member (Finance) of the Viceroy's Council had written, "We find Venkataraman is most useful in the Finance Department being, in fact, one of our best men". Raman, in his short stint with the Finance Department acquired a reputation that he might even become the first Indian Member for Finance in the Viceroy's Council. Sir C.D. Deshmukh, the first Indian Governor of the Reserve Bank of India had even said that the Bank's starting was based on a paper initiated by Raman in those early days.



Plaque at the entrance of the Treasury Buildings.

"The essence of science is independent thinking and hard work, not equipment"

-Raman

IV. The Scientist in Calcutta - The Golden Era.

Sir Asutosh Mookerjee was appointed the Vice Chancellor of the Calcutta University in 1906. His prime focus was to strengthen Science Education. He raised donations to the tune of several lakhs of rupees and established the University College of Science. In the names of the principal donors several chairs were also established. Notable amongst them were those named after Sir Taraknath Palit and Sir Rashbehari Ghosh.

Sir Asutosh scouted for the best available talent for appointment to the various faculty posts. For the Palit chair for physics, he zeroed down on Raman, who at that time was firmly settled in his senior government position. The Financial Civil Service offered Raman everything in life from job security to further career opportunities to time for devoting to Scientific Research as a meaningful pastime.

However, the scientist in Raman was overjoyed on receiving the offer for the Palit Chair. Accepting the Palit Professorship meant a huge pay cut from Rs.1100 to Rs.600. The Finance Department was also not quite happy with Raman's interest in the offer. With the impending Indianisation of the Government Establishment, there was a chance that Raman, as one of the best officers could go on to become the Member (Finance) in the Viceroy's Council. It was thought that Raman would go on a leave and try out the Professorship.

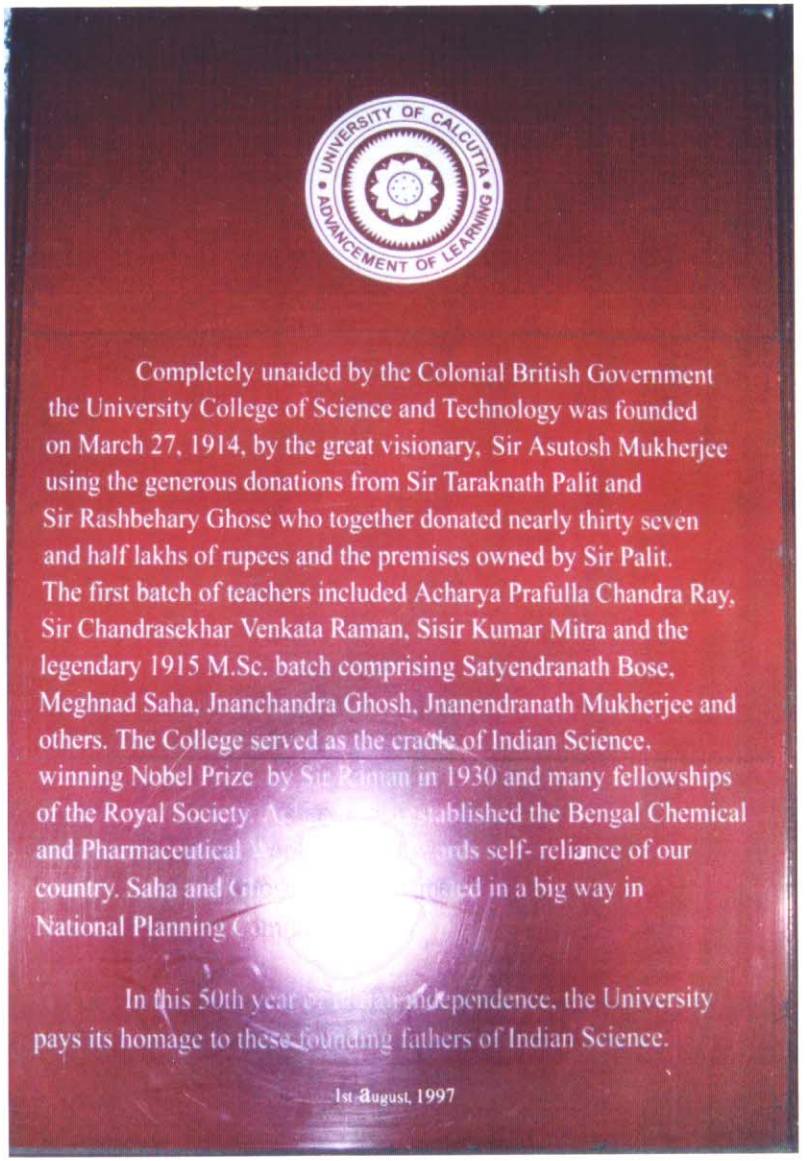
However, Sir Harcourt Butler, the Member (Education) insisted that Raman resign from the Government job before taking up the Palit Chair. Thus, in July 1917, Raman had to finally quit the Financial Civil Service, which had helped him in securing a firm place in the scientific fraternity in Calcutta and India.

Sir Asutosh Mookerjee succeeded in his endeavor to enrich the Scientific-Academic world with Raman's talents at the expense of the Finance Department. Later, Rajaji paying a tribute to Sir Asutosh said that but for him, Raman might have retired as a faultless Accountant General.

In 1917, Raman finally entered the Academic world, after a minor ego-clash with the authorities over a stipulation requiring the Palit Professors to be trained in England. Raman refused to go to England in order to get "trained", and finally the authorities had to yield.

Thus began the Golden Era of science in Calcutta.

The fact of Raman leaving the Government job did not translate into a less hectic lifestyle. Even after taking the Professorship, Raman had to divide his time at two work places, the Calcutta University and the Indian Association for the Cultivation of Science. Although Raman's duties as a Palit Professor were primarily research oriented, he was also highly enthusiastic about teaching Physics. Raman's dedication towards research continued to intensify and he started working late at nights,



Commemorative plaque at the University of Calcutta.

Group photographs - Calcutta University

often sleeping on a table in the Association premises, to be woken up by Ashu Babu on the next morning. Raman's interaction with students at the Association and University alike, led him to delve into a greater variety of problems. In 1919, Amrita Lal Sircar passed away and Raman was elected the Honorary Secretary of the Association. On assuming the

position, Raman's vibrant personality and keen intellect started reflecting in Annual Reports of the Association, which were submitted to the Management committee.

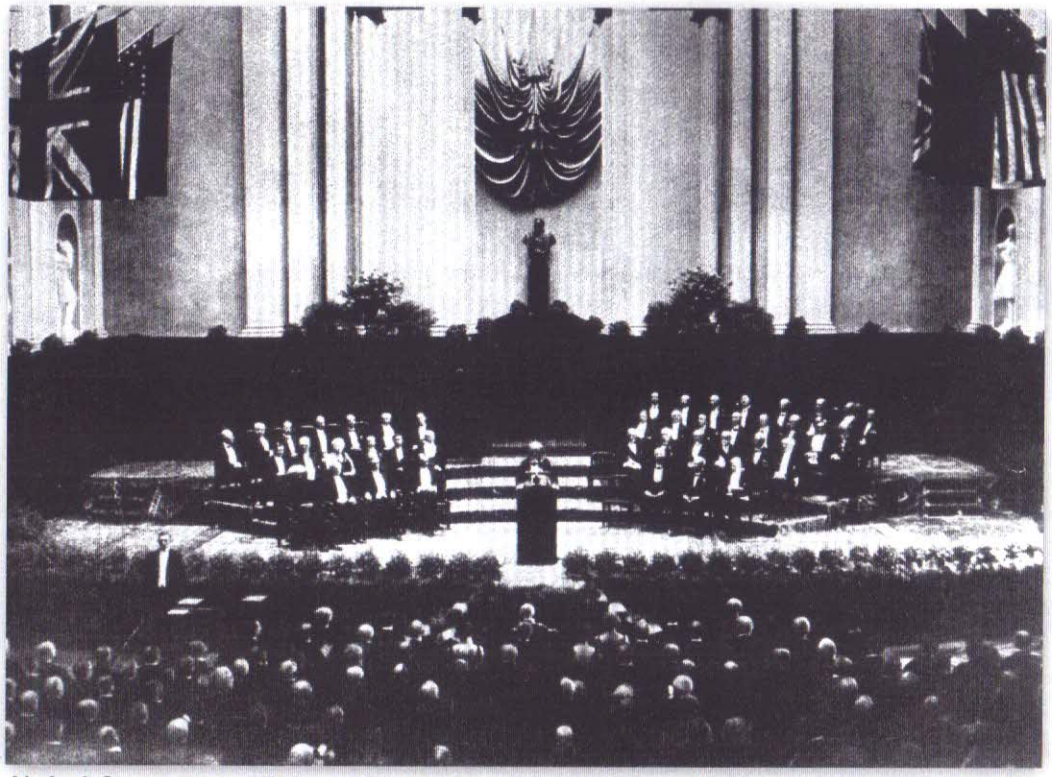
Sir Raman at the Niels Bohr Institute, Copenhagen

Raman was able to attract the best scientific talent to Calcutta and with Raman at it's helm, the Indian Association grew in reputation and it's publications soon carved out a niche in the global scientific scene. In 1921, the Calcutta University honoured Raman with an honorary doctoral degree. Prior to that he did not have this degree specifying that the holder is capable of conducting original research! However, Raman had been guiding other students towards their doctoral degrees.

At the age of thirty-six, in 1924, Raman became the fourth Indian to be elected Fellow of the Royal Society. In the early 1920s Raman made a few visits abroad, as a delegate in different fora. He got an opportunity to interact with many of his illustrious contemporaries like J. J. Thomson, Bragg, Rutherford, Compton, Goldschmidt, and Rozhdestvenskii etc. The visits abroad, brought about a change in Raman's habits and methods of work. Although he maintained his hectic lifestyle, he became more particular about his meals. He also started taking out time for recreation and relaxation.

On February 28, 1928, the Association became abuzz with excitement. Raman and his students had discovered a new phenomenon.Everyone in the Association began demonstrating the phenomenon enthusiastically to the visitors. Satyen Bose on being shown the phenomenon remarked, "Prof. Raman, you have made a great discovery. I predict that this effect would be called the Raman effect and I also predict that you will get the Nobel Prize for it." And it happened likewise.

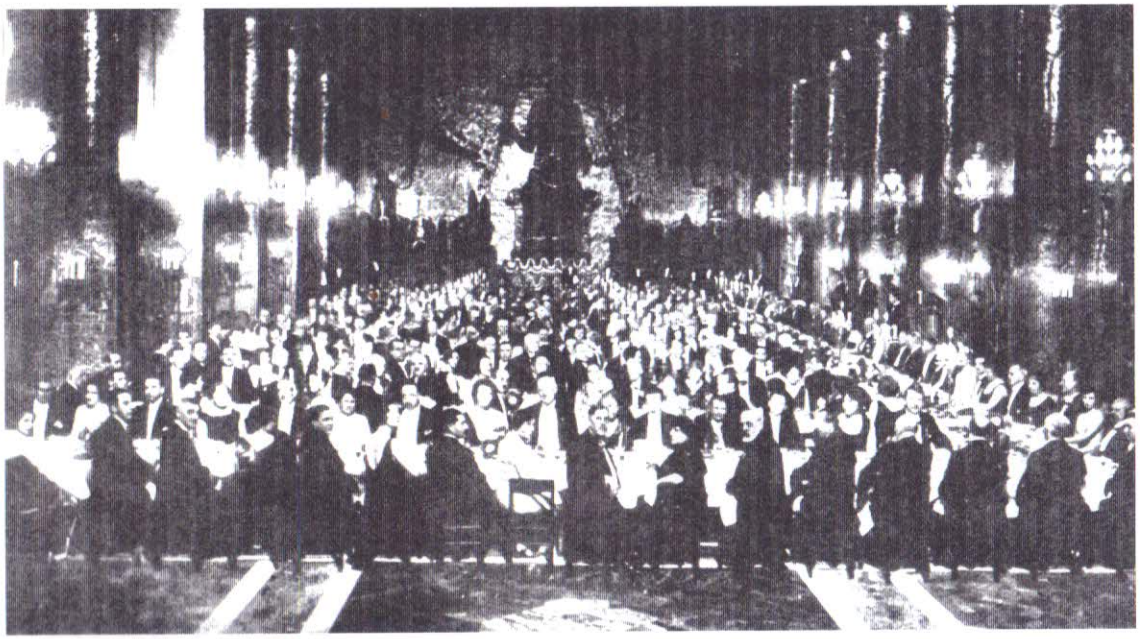
The Nobel Prize for physics was conferred on Sir C. V. Raman in 1930. A week prior to that, he was also awarded the Hughes Medal and Premium for 1930 by the Royal Society of London. This award is also a benchmark for scientists involved in original research in Physical Sciences and prior to Raman, had gone to many Nobel Laureates.



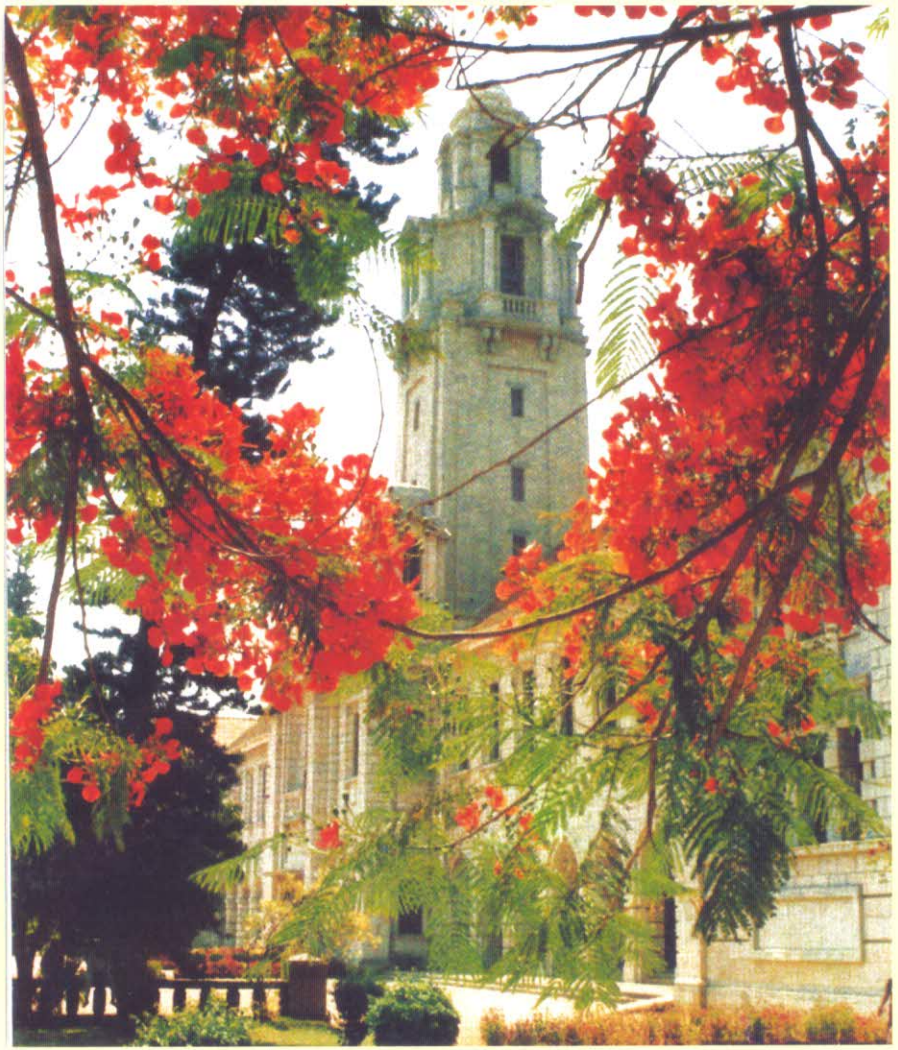
Nobel Ceremony --Raman First row extreme left sitting under the British Flag

The Nobel ceremony took place on the 10th December 1930, between 4 and 7 P.M. Lady Lokasundari Raman also attended the ceremony.After his return from Stockholm, Sir Raman was accorded a Civic Honour in Calcutta. On 26th June 1931, before a distinguished gathering, the Calcutta Municipal Corporation presented the Civic Address in honour of Sir Raman at the Town Hall, which is separated by a narrow street from the Treasury Buildings, where Raman first started off in Calcutta as an Assistant Accountant General.

At the ceremony, Raman paid wholesome tribute to the great city of Calcutta. To the Mayor's desire that Raman's association with Calcutta be a permanent one, Raman replied "I consider it my great good fortune to have been a citizen of Calcutta for nearly 25 years. Some have said that research work cannot be carried on successfully except in cool climates such as those of Bangalore or Dehradun. A hot day in June is not an opportune moment to enter upon praise of the physical climate of Calcutta. But from the point of view of research, there is something more important than physical climate, and that is the intellectual climate of the environment. For a hundred years, Calcutta has been the intellectual metropolis not only of Bengal or of India, but also of the whole of Asia. From Calcutta has gone forth a living stream of knowledge in many branches of study. It is inspiring to think of the long succession of scholars, both Indian and European, who have lived in this city, made it their own, and given it of their best. It must be a profound privilege to work and live in such an environment."



The banquet after the Nobel ceremony. Raman with turban centre of extreme right row.



Indian Institute of Science BANGALORE

In Calcutta, Raman was transformed into a world-class scientific professional from an amateur hobbyist. Raman left Calcutta at the pinnacle of his career in 1933, to become the Director of the Indian Institute of Science at Bangalore.

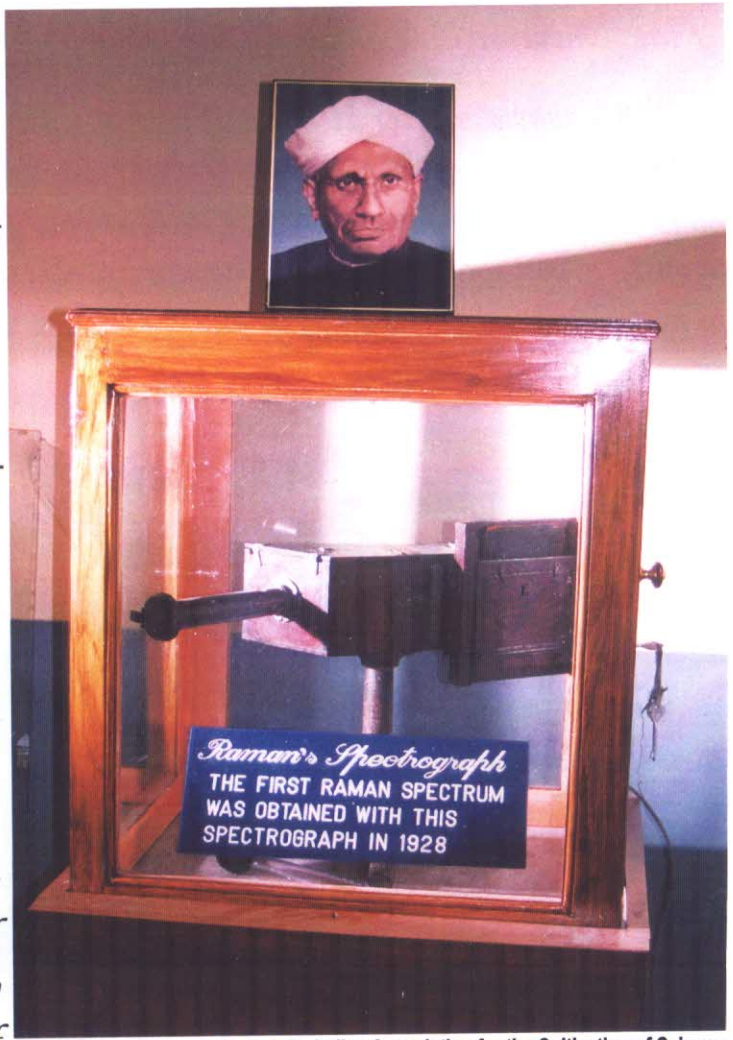
"Ambition, Courage and Endeavour have been my watchwords"

-Raman

V. Brief Insight into Raman's Works – Scientific Excellence

Although Raman had a keen research oriented mindset since his childhood, his organized research began in his University days, when he started making full use of the free time given by his lecturers. Raman's scientific interest spanned over diverse areas of Physics. Often his research issues were built up from keen observation of different physical phenomena followed by intense self-questioning. Raman did not allow himself to be hindered by the lack of adequate scientific instruments.

The first of Raman's papers at the University was regarding "Unsymmetrical diffraction bands due to rectangular aperture" which examined the problem of the passing of light through a rectangular slit and the bands formed as a result of that. Raman gave the manuscript to Prof. Jones at his University for comments. As Prof. Jones sat on it for a long time, Raman took a bold step and sent the manuscript to the Philosophical Magazine in London. It was duly published in November'1906 with Raman as the sole author and no acknowledgements.

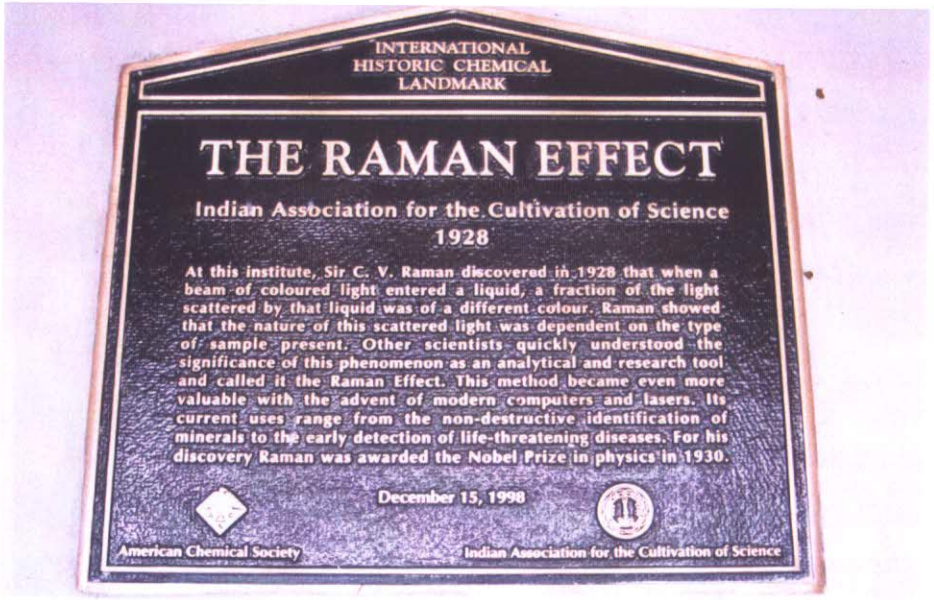


Raman's spectrograph, kept at the Indian Association for the Cultivation of Science.

During his college days, another of his papers titled 'The curvature method for determining the surface tension of liquids' was also published in the same journal. This paper pertained to the determination of the capacity of liquids to form bubbles and thin films. Raman was a keen observer of various natural phenomena and sought to delve deeper in the various causes and effects pertaining to them.

Raman himself described his Calcutta days as the Golden Era. Raman's main areas of research became vibrations and optics, however often he strayed into other spheres of research.. In 1921, Raman made his first visit to England, as a delegate to the Universities Congress at Oxford. In London, he carried out studies on conical refraction in biaxial crystals.

He was a master at playing various instruments. This prompted him to research more into the acoustics of Musical instruments. He worked on the Veena, Tanpura and Mridanga. Raman sought to explain through his papers, some known facts about the instruments and also gave new discoveries. He also invented new instruments for study of noises and sounds. Raman also conducted extensive studies on the whispering Galleries at St. Paul's Cathedral in London, the Victoria Memorial in Calcutta and the Granary at Patna.



Commemorative plaque at the Indian Association for the Cultivation of Science

The Nobel Medal

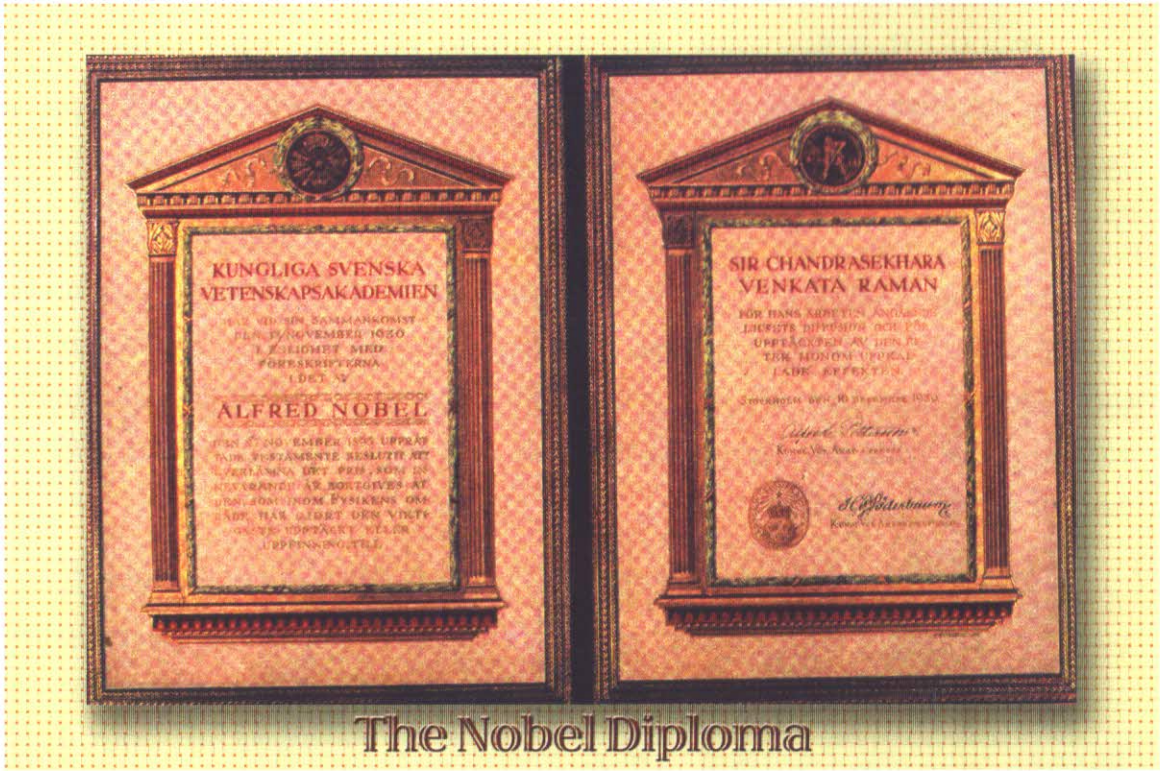
For the first few years after his joining the Calcutta University Raman focussed his efforts towards investigating physical problems relating to the production of colour vis-à-vis natural phenomena. He also worked on the properties of light during it's transmission around obstacles. Raman investigated into the colours shown by the striae in mica, by mixed films of air and water, by colloidal sulphur in water and by liquid emulsions.

During his visit to Europe in the summer of 1921, Raman studied the wonderful Blue colour of the Mediterranean Sea and of Oceanic waters in general. While fellow travellers were enjoying the Sea voyage, Raman would be busy researching the colour of seawater. Raman worked in detail on the effect of movement of light in transparent liquids like water. He was able to prove that not only in liquids but also in transparent solids like ice and quartz, light is scattered as a result of the motion of the molecules.

Raman investigated the structure of liquids by means of x-rays. Along with his co-workers he investigated the structural x-ray patterns of a large number of liquids, liquid mixtures and solutions. The results so obtained were of great value to both Physics and Chemistry.Raman undertook the study of the crystal structures. He also studied the optical behaviour of substances when placed in strong magnetic fields.Raman did not leave any area of physics untouched. He also worked on Waves and Ripples, Convection of heat, Kinetic theory of gases, Electrical properties of molecules, Photoelastic phenomena, emission of light by solids etc.

During his final years, Raman also got drawn deeply into Astronomy. He started the construction of a small observatory. Raman also researched with many scientific phenomena purely for recreation. He examined flowers in natural as well as artificial conditions in an effort to identify the phenomena responsible for their varied colouring patterns.

The Crowing Glory of all his works was the Nobel Prize in Physics, which he got for discovering a phenomenon that has become famous as the Raman Effect. In simple words it can be stated as the phenomenon by which the colour of light changes due to scattering. Ordinary white light that is received from the Sun is composite and consists of many colours. The same can be separated by passing through a glass prism and the rainbow like band is known as a spectrum.



The Nobel Diploma

To observe the Raman Effect, one has to study the light entering into a substance, which is at least, partially transparent. The light emerging from the interior after being scattered by the molecules within, is also to be studied. But this study is to be done by using monochromatic light (of a single colour) and not white light. If studied by using the prism of a spectroscope (the instrument used by Raman to discover the effect), it is found that the scattered spectrum of the monochromatic light contains colours or rays in addition to the original colour or ray. These new rays are actually produced by the action of molecules of the substance. That is to say, they act upon the incident (incoming) light ray and cause it in part to change into new colours or rays.

"There is only one solution to India's Economic problems and that is science, more science and still more science."

-Raman

VI. Raman - The Missionary Scientist

Throughout his life, Raman had just one mission: to delve deeper into the wonders of physics. To achieve his mission, Raman worked with unbridled energy and unending passion. Even during the two short spells when the officer Raman had to serve in Nagpur and Rangoon, the Scientist Raman continued his good work in improvised laboratories, only to consolidate on return to Calcutta. Raman had every trait expected of a scientific missionary, a keen intellect, excellent oratorial skills and a sharp and highly critical, at times sarcastic tongue. With these assets Raman set out to achieve his dream of universalising Science in the country. Raman's doors were always open for willing students. At times he even bore the initial living costs of his students.

Group photograph- Accountant General office, Rangoon

Raman, third from left, seated on chair.

The whole country erupted in joy, on receiving the news of Raman receiving the Nobel Prize. It was doubly sweet that an Indian had won the Nobel at a time when, being British subjects, Indians were not thought of as being capable of such achievements. Raman's achievements furthered the cause of development of science in India.

Raman was highly patriotic, even though at times he may have also conveyed a contrary impression by taking classes in the University when nationalist students and teachers used to boycott the British institutions. During the Nobel ceremony, tears rolled down Raman's eyes and on being asked later as to why he had wept, Raman said that he regretted winning the prize under the British flag rather than doing so under the Indian flag.

Raman had been averse to the idea of going abroad for training. Throughout his career he maintained his pride in his independent work in India. He also used to claim bluntly that given a chance, he was willing to train foreigners in India. However Raman was appreciative of his great foreign contemporaries. He arranged various lectures by them in their respective areas of specialization. He also made an unsuccessful attempt at harnessing the oppressed German Scientists' skills for the betterment of Indian institutions. His efforts in this direction were thwarted by his Indian contemporaries.

After leaving Calcutta, Raman continued his good work of a Missionary Scientist in Bangalore. He took over as the Director of the Indian Institute of Science, but soon lost the position owing to a rebellion of a few egos. But Raman continued as a Professor of Physics.

Raman was instrumental in laying the foundation of the Indian Academy of Sciences at Bangalore. This Academy served as a forum for fruitful interaction between the scientists of different disciplines. Many important and informative lectures, discussions and publications emanated from this academy and served to guide the future torch - bearers of the scientific community in the country.

The Raman Research Institute

Raman's retirement from the Indian Institute of Science did not imply his retirement from research work. Raman continued with his research work by setting up his own research institute, The Raman Research Institute. Raman conceptualised the Institute, two years before his retirement. The Maharajah of Mysore gifted the land required for setting up the Institute. However, for construction of the building funds were a constraint. Raman went around the country, collecting donations from all and sundry.

Apart from his missionary zeal for development of science, Raman was also a pragmatic thinker. The idea of raising resources for self-financing of educational and research institutions, which is so much in vogue these days, appealed to Raman in the 1940s.Perhaps, Raman's experience in the Finance Department helped in developing such pragmatic thinking! He started a few chemical industries along with his former student for financing the day to day functioning of the Institute.Raman was also a keen lover of natural beauty. He took great care in the development and upkeep of gardens in all the institutes where he served. Raman was especially fond of Rose gardens.Raman's fascination for colourful objects made him a keen collector of crystals, gems, minerals, rock specimens, shells, stuffed birds and butterflies.

Raman, with children.

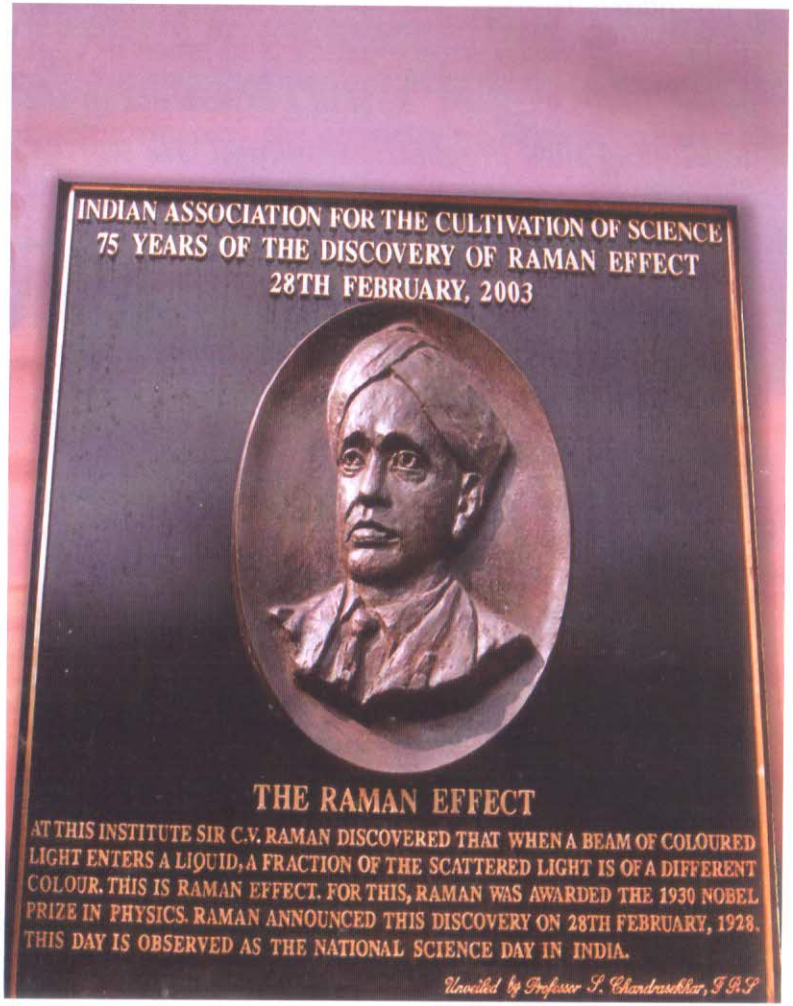
However, some years after his retirement, Raman became bitter and critical of his contemporaries, including Nehru. The issues were varied. Although none questioned the actual benefits of science for the impoverished and newly independent India. There were disagreements regarding the means and the specific ends to be achieved vis-à-vis scientific development in the country.

However, he became his normal self again by associating with children and youth. Raman also instituted a Gandhi Memorial Lecture, which he used to deliver on 2nd October each year.

Shortly before his 82nd birthday, Raman became ill and had to be hospitalised. Raman recovered from the illness for a brief period, but got depressed at being unable to maintain his normal routine.On 21st November 1970 Raman bid goodbye to fellow mortals. As per his wishes, his remains were cremated in the grounds of the Raman institute, sans any religious ceremonies. The great son of India and an unparalleled Officer Scientist left for his heavenly abode after immortalizing himself with his work and the scientific edifices, which he built and strengthened for serving the nation for years to come.

Honours for Sir C. V. Raman

Curzon Research prize.
Woodburn Research Medal.
Elected Fellow of the Royal Society.
Matteucci Medal - Societa Instaliana Della Scienza, Rome.
Knighted by the British Government in India.
Hughes Medal - Royal Society, London.
Nobel Prize for Physics.
Rajasabhabhushana - Decoration by the Maharajah of Mysore.
Franklin Medal Franklin Institute, Philadelphia.
Appointed National Professor.
Bharat Ratna.
Lenin Prize - U.S.S.R.
Honorary Doctorates from the Universities of:
Allahabad, Benaras, Bombay, Calcutta, Dacca, Delhi, Freiburg, Glasgow, Kanpur, Lucknow, Madras, Mysore, Paris and Patna, Osmania University, Hyderabad and Sri Venkateshwara University, Tirupati.
Honorary Member:
Deutsche Akademi of Munich
Hungarian Academy of Sciences
Indian Science Congress Association
Royal Irish Academy.
Royal Philosophical Society, Glasgow
Zurich Physical Society.



Commemorative plaque at the Indian Association for the Cultivation of Science marking 75 years of discovery of Raman effect.

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