C V RAMAN AND THE GERMAN CONNECTION

S RAMASESHAN

CHANDRASEKHARA VENKATA Raman (C V Raman) was one of the legends of Indian science. The discovery he made in 1928, the Raman Effect, for which he was awarded the coveted Nobel Prize, has never been surpassed in quality by any other made in India. His incredible career evokes many questions. What prompted him to do science at such a tender age? Where did he acquire such a passion for Nature, which provided him the problems for his famous discoveries? Seeking for answers to such questions I found there were many connections between Raman and Germany.

Raman was born in 1888 of poor parents; even in his teens he had an unusual yearning to understand the nature of things. He started experimental science in his college at Madras at the age 15. Since research was not yet a profession in India he appeared and passed the Financial Civil Service Examination and at the age of 18 was appointed the youngest Assistant Accountant-General in the Government of India. While he did his office work with diligence he pursued science "before and after office hours" mainly at a place he had discovered in Calcutta — the Indian Association for the Cultivation of Science (IACS) — which was a haven to him.

His scientific investigations attracted the attention of scientists both inside and outside India. Sir Ashutosh Mukherjee, the Vice-Chancellor of the Calcutta University, known for encouraging and gathering exceptional talent in the country, was so struck by Raman's genius that he offered him a Chair of Physics. Raman accepted it in 1917 although he suffered considerable financial loss. He attracted a large number of students and IACS became a hive of scientific activity. It was here that he also made the discovery which made him and India famous.

Later, in 1933, he left Calcutta to become the Director of the Indian Institute of Science (IISc), Bangalore. On his formal retirement from IISc, he established the Raman Research Institute in 1948. He trained scores of students, published hundreds of scientific papers and monographs, founded the Indian Academy of Sciences in 1934, started and ran many scientific journals, and carried on his personal research right up to his death in 1970. During this remarkable career Raman made many major scientific discoveries in such fields as acoustics, ultrasonics, optics, magnetism, X-rays and crystal physics. His interests were wide, from astronomy and meteorology to physiology.

To a country that was fighting for independence and trying to establish its identity, he became a symbol of its intellectual resurgence, to both young and old, because of the impact he made on the rest of the world. When he died in 1970, the President of India said:

> "C V Raman was a great teacher. His knowledge was not confined to the physical sciences. In this over-specialized world his breadth of knowledge was remarkable. He combined the highest intellectual integrity with a winning warmth of heart.... He was our most illustrious scientist who continued for many years to guide the scientific progress of India."

C. V. Raman

Raman and Helmholtz

Raman had never been outside India till 1921. Yet what prompted him to pursue, with almost inexplicable vigour, modern science, which is considered by many to be a western implant? Apart from his native talent did anyone inspire him? I discovered recently a transcript of a speech by Raman entitled "The books that influenced me" which gave one answer to this question.

Just as Raman dominated the Indian scientific scene in the first half of the twentieth century, Hermann von Helmholtz bestrode German science during the mid-nineteeth century. His wide ranging and exact work brought Germany to the forefront of world attention, a position she was to enjoy well into the twentieth century. Helmholtz was an inspiration to many, including his most distinguished student Heinrich Hertz, the discoverer of radio waves. There is no doubt that Raman too was inspired by Helmholtz. So great was this impact that young Raman actualiy puts von Helmholtz on par with the great Newton. He said in his speech:

> "Speaking of the modern world the supremest figure, in my judgement, is that of Hermann von Helmholtz. In the range and the depth of his knowledge, in the clearness and the profundity of his scientific vision he easily transcended all other names I could mention, even including Isaac Newton. Rightly he has been described as the intellectual colossus of the nineteenth century. It was my great good fortune, while still a student at college, to have possessed a copy of an English translation of his great work *The Sensations of Tone*. As is well known this was one of Helmholtz's masterpieces. It treats the sub-

jects of music and musical instruments not only with profound knowledge and insight, but also with extreme clarity of language and expression. I discovered the book myself and read it with the keenest interest and attention.

It can be said without exaggeration that it profoundly influenced my intellectual outlook. For the first time I understood, from its perusal, what scientific research really meant, and how it could be undertaken. I also gathered from it a variety of problems which were later to occupy my attention and keep me busy for many years."

Raman's researches on the musical instruments of India

It is said that orientalists owe the composer Mendelssohn much, as he dissuaded Max Mueller from devoting himself to his first love — music! Max Mueller therefore turned to linguistics with his heart and soul and as a result could expound the culture of the east to the rest of the world. I think we owe it to Helmholtz that Raman took up the scientific study of Indian musical instruments and brought out some of the most unexpected aspects of their design. It was Raman's view that although music played an important role in the cultural life of ancient India, the material now available for writing its history is all too meagre. A better method of probing into the development of musical knowledge in ancient India would therefore be a scientific study of the musical instruments which have been handed down as heirlooms for untold generations.

The work of Raman on the musical drums of India is epoch-making and reveals the acoustical knowledge of the ancient Hindus — which is the title of a paper published by Raman. It was Pythagoras who first formulated what makes a sound seem musical to the human ear. If the string of an instrument is plucked (struck or bowed) it not only emits a note having a fundamental frequency, but also produces higher notes. If these overtones are in the ratio of the natural numbers (2,3,4 etc to the fundamental), the effect is musical, otherwise it is discordant or unpleasant (see SCIENCE AGE, September '86, p 63). Scientifically it is well known that percussion instruments as a class can only produce inharmonic overtones and are therefore in a sense only noise makers. Raman's ear however detected that the Indian percussion instruments stand in an entirely different category in that they produce truly musical sounds. He showed that this was achieved by the partial loading of the drum membrane with a firmly adherent but flexible paste. As a consequence the Indian *mridangam* or *tabla* produces a succession of musically harmonic overtones in the same way as any stringed instrument.

The famed stringed instruments of India, the *vina* and the *tanpura*, are of undoubted antiquity and revered as a gift of the gods because their sound is considered closest to the human voice. Their tone exhibits a quality much superior to most "plucked" instruments. Raman made the surprising discovery that certain overtones, which according to acoustical principles should be entirely absent, sing out with great intensity in these instruments. He showed that the violation of what is called the Young-Helmholtz

Arnold Sommerfeld

law is due to the curved bridge which the ancient Hindus had cunningly fashioned so that the *vina* (and the *tanpura*) could produce sounds richer in quality, worthy of Saraswati, the goddess of music whose favourite instrument it was.

Raman's acoustical studies were not confined to Indian musical instruments and they extended also to other western ones. While his wife was an accomplished *vina* player, it is hardly known that Raman himself was once a reasonably competent violin player. His mathematical theory of the bowed string and its experimental verification, his theory of how the impact of the hammer produces the exquisite vibration in the pianaforte and his demonstration of the peculiar Wolf Note produced by the violin and cello were all accepted and recognized by the experts of the musico-acoustical world. As a consequence he was invited to contribute to the *Handbuch der Physik* (published by Springer Verlag). This article entitled "Musikinstrumente und ihre Klange" (Musical Instruments and Their Tones) published in this prestigious German encyclopaedia of physics is considered an authoritative one on this subject. Raman wrote the article in English and it was translated into German. My attempts to get the original English version that Raman wrote for publication in "The Collected Works of C V Raman" were unsuccessful.

In the talk referred to earlier about Helmholtz, Raman greatly regretted that he could not read the other classic of Helmholtz — *The Physiology of Vision*—"as it had not been translated into the English language". In the twenties Raman could read with facility scientific monographs written in German and he could even manage to speak the language (at least to non-Germans!). When he first went to the USSR, German was the only language of communication. The story goes that in Leningrad Raman was shown by a professor a recent experiment he had performed on anomalous dispersion. On seeing it Raman exclaimed:

"Das ist sehr Schon. Aber ist es nicht Rozhdestvenskii-Experiment?" (This is very beautiful; but is it not the Rozhdestvenskii experiment?).

To which the Professor replied:

"Ja. Ich bin Rozhdestvenskii." (Yes. I am Rozhdestvenskii).

The blue of the sea

On his first journey to Europe in 1921 Raman was struck by the incredible beauty of the blue of the Mediterranean Sea and saw in it a vision of a vast world of knowledge awaiting his study. By performing an elegant but crucial experiment on board the ship (with optical components he had with him) he was able to disprove a conjecture made by Lord Rayleigh, that the blue of the oceans was due to the reflection of the blue skies in the waters. In 1922 he wrote the famous monograph *Molecular Diffraction of Light.*

There are two aspects of light. One is that it consists of electromagnetic oscillations (Maxwell and Hertz). The other is the complementary view propagated by two of the greatest scientists of this era, Max Planck and Albert Einstein, that it consists of particles (quanta) and that certain observations like the photoelectric effect, incidentally discovered by Hertz, can only be explained on this basis. In the monograph referred to above Raman says that if scattering of light is considered as a collision of a light quantum with a molecule many concepts

derived from the classical wave theory may be violated.

Raman's discovery and the Kramers-Heisenberg theory

For the next six years Raman drove himself and his students to see whether these violations could be discovered. He finally succeeded on 28 February, 1928. It was shown that the light quantum and the molecule do exchange energy which manifests itself as a change in the colour of the scattered light. (Sometimes the light quantum gave a part of its energy to the molecule to excite it and the quantum was scattered with diminished energy and at other times it was scattered with greater energy by acquiring some from the vibrating or rotating molecule.)

Historically, A Smekal in 1923 published a note in the journal *Naturwissenschaften* considering the quantitative aspects of the collision process that Raman thought of in his *Molecular Diffraction of Light.* Unfortunately, this paper was not noticed by experimental physicists including Raman and his group. Two years later, in 1925, Kramers and Heisenberg (two great names in European physics) developed Smekal's idea in a paper which is now considered one of the classics in physics. (It may be noted that Heisenberg was to invent quantum mechanics, some of it based on this paper, and to revolutionize physics thereby.) Their paper contained many beautiful but complex ideas, but again their experimental implications were not obvious nor were they made clear in the paper. However, Raman seems to have perceived their import. In fact when hot on the trail (three weeks before the actual discovery of the Raman Effect) K S Krishnan, *the* major collaborator of Raman, writes in his diary:

> "February 7th Tuesday: Professor (Raman) came to the house — about 9.00 pm — and called for me. We (Venkateswaran and Krishnan) went down. We found him very excited and he had come to tell me that what we had observed that morning must be Kramers-Heisenberg process we had been looking for all these days. We, therefore, agreed to call the effect MODIFIED SCATTERING."

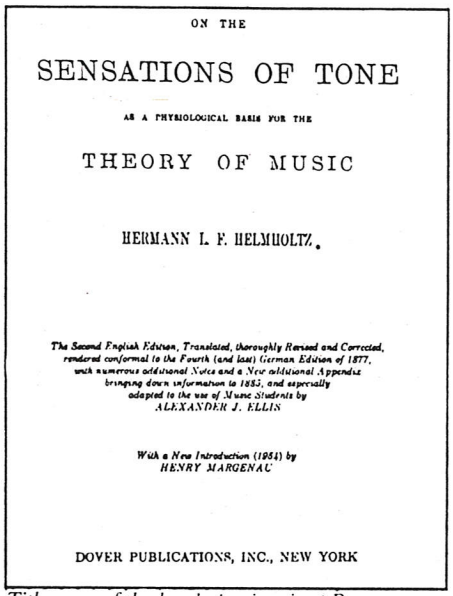
The visit of Arnold Sommerfeld to Raman's laboratory

Sommerfeld, the renowned German physicist, author of th classic *Atombau und Spectrallinien,* and who shaped theoretical physics in Germany by the style of his lectures and his remarkable qualities as a teacher, decided to go to the United States through the eastern route (via India). He was:

> ".... especially attracted by the wonderful land of India because of its exotic buildings, fantastic religions with their philosophical systems; and also because it was in this ancient land that during the last few years strong shoots of modern physics had grown by which India suddenly emerged in competition in research as an equal partner with her European and American sisters."

About this it is said:

> "Sommerfeld was thinking of the spectroscopic effect discovered by Raman which like no other discovery attracted attention and enthusiastic cooperation all over the world."


ON THE

SENSATIONS OF TONE

AS A PHYSIOLOGICAL BASIS FOR THE

THEORY OF MUSIC

HERMANN L. F. HELMHOLTZ.

The Second English Edition, Translated, thoroughly Revised and Corrected, rendered conformal to the Fourth (and last) German Edition of 1877, with numerous additional Notes and a New additional Appendix bringing down information to 1885, and especially adapted to the use of Music Students by ALEXANDER J. ELLIS

With a New Introduction (1954) by HENRY MARGENAU

DOVER PUBLICATIONS, INC., NEW YORK

Title page of the book that inspired Raman

When Raman heard of Sommerfeld's intention to take the eastern route he sent a telegram (11 February, 1928):

> "Calcutta University inviting you, lecture honorarium thousand rupees. Kindly wire date arrival India."

As soon as Sommerfeld arrived in India (as is not unusual with foreigners!) he took ill and spent two weeks in a hospital in Bangalore. On 4 October, 1928 he arrived in Calcutta and on the same day visited Raman's institute (IACS). Raman showed how using light and a small spherical ball he was able to verify some of the theories of Sommerfeld on the propagation of radio waves round the Earth! Wrote Sommerfeld:

> "Everything in the institute very good; but bathrooms terrible!"

Sommerfeld's visit to India was, in my view, very significant as he was the first discriminating scientist to come to Raman's laboratory and to see the demonstration of the new discovery. There were some who have even later expressed some scepticism as to whether Raman could have observed his effect visually as the intensity of the Raman Scattering would be only a hundred millionth that of the incident light. They could not imagine the power of sunlight in India which was why Raman chose it for his studies nor did they reckon with the ingenuity that is evoked when a man of genius is short of funds and equipment!

On 6 October, Sommerfeld "eventually saw the Raman Effect visually...." On Sunday,'7 October, he heard "a wonderful lecture by Raman — also that the rotations of molecules can be seen (unresolved) as the modified radiation" and on subsequent days "saw the blue green in an ice block — obviously modified scattering". Indeed so convinced was Sommerfeld of the reality of the Raman Effect that he proposed Raman as a candidate for the Nobel Prize. There were at least 10 others who also proposed his name for the Nobel Prize.

Sommerfeld after a serious conversation with Raman comments critically on India's economic and political conditions and her difficult relations with Great Britain. He left India

> "with deepest affection for the highly gifted but unhappy nation with sincere gratitude for many acts of friendliness and honours bestowed on him."

Sommerfeld and Raman became very good friends. On his way back from receiving the Nobel Prize in 1930 Raman visited Sommerfeld in Munich. He was received with great joy:

> "We welcome our guest not only as a successful scientist and discoverer but also as a representative of the age-old and now rejuvenated culture of the orient which trustfully cooperates with the occidental culture and strives for the same ends."

It is not so well known that S Chandrasekhar the astrophysicist (also a Nobel Prize winner), when just 18 years old, met Sommerfeld in Madras during his 1928 visit to India. They discussed the new developments made by Sommerfeld on the theory of metals where he had used Fermi-Dirac statistics. Chandrasekhar went on to extend this to the case of stars which led to one of his important discoveries.

Among the other visitors to the IACS were von Karman in the summer of 1928 and Heisenberg (1929) when he was not yet 28. Unfortunately, I have not been able to get authentic accounts of these visits.

The Raman Effect — Pringsheim

The possibility of the existence of the effect discovered by Raman was obviously inherent in the Kramers-Heisenberg paper and in quantum mechanics. As Born says in 1928, just six months after the discovery:

> "Raman's discovery is predicted in its entirety by quantum mechanics and could be thought of as a proof for the same."

Then one can ask whether a dozen distinguished men of science proposed Raman to the Nobel Prize just because he found a proof for quantum mechanics. The answer is a definite no. One thing is quite clear — that the implied prediction was obscure even to the theorists and definitely so to the experimenters at that time. The discovery did come as a surprise to everyone. We see an element of this in what Einstein said:

> "C V Raman was the first to recognize and demonstrate that the energy of a photon can undergo partial transformation within matter. I still recall vividly the deep impression that this discovery made on all of us..."

In August 1928, Prof Peter Pringsheim of the Berlin University published a paper in *Naturwissenschaften* which reported a detailed study (done with the proverbial German thoroughness) of the various then known scattering processes and concluded:

> "What has been discovered by Raman is an entirely new phenomenon worthy of being designated "The Raman Effect" and the spectrum of new lines associated with it as "The Raman Spectrum" ....
>
> "One can state without doubt that through his discovery Raman has opened up a vast and completely new field of spectroscopy."

This was possibly the reason why the Raman Effect was so enthusiastically welcomed and commended by the leaders of science.

Laue aufnahmen or Laue photographs

The results coming out of Raman's laboratories were so profuse that he needed journals near at hand to publish all of them. In his early days in Calcutta he founded the *Proceedings of the Indian Association for the Cultivation of Science* (1917) and later the *Indian Journal of Physics* (1926). When he moved to Bangalore he started the *Proceedings of the Indian Academy of Sciences* (1934). He has been closely connected with *Current Science* since its founding in 1932. All these journals are still doing well.

One of the greatest discoveries of modern physics was the diffraction of X-rays by crystals by Max von Laue. When *Current Science* decided to bring out a special number in 1937 to commemorate the silver jubilee of this discovery it was a collaborative effort between India and Germany. Dr Adolf Berliner, the editor of *Naturwissenschaften* and Prof Max Born took special interest in this issue and used their personal influence with their friends to get special contributions. The result was that a galaxy of scientists sent in articles — among the authors were Laue himself (Germany), William and Lawrence Bragg (UK) who were responsible for so much development of the X-ray crystal structures of inorganic, organic, mineral and metallic materials, Ewald (Germany/US) who was associated with X-ray crystallography even before its discovery and has done so much for its growth, Manne Siegbahn (Sweden) who made X-ray spectroscopy into a precise and quantitative field, Linus Pauling (US) who made the remarkable connection between X-ray structures with chemistry and biology, Hermann Mark (Germany/US) who started as an X-ray physicist but did pioneering work on polymers and J A Prins (Germany) who elevated the qualitative theory of X-ray diffraction of liquids developed by Raman and his school to a precise quantitative one.

Raman and Heisenberg

In his introduction Raman thanks these leading authorities in X-ray physics for their contributions and pays tribute to two outstanding experimental discoveries made in Germany:

> "Students of optics recognize in Prof Laue a great exponent of their science .... While the work of Hertz opened up the possibility of communication with *distant space,* Laue's work brought the submicroscopic world within the range of direct observation."

Laue (in 1912) discovered that when an X-ray beam is diffracted by a crystal, this geometric diffraction pattern can be registered on a photographic plate. Such patterns have been called by generations of crystallographers as Laue aufnahmen — Laue photographs.

A meeting was held in 1948 in Boston (USA) when a large number of scientists of the world gathered to decide on the establishment of an International Union of Crystallography. On one of the days many scientists were relaxing at a beach near Boston. Amongst those were some well-known ones, von Laue, Lawrence Bragg, Paul Ewald, Raman, Patterson, Hermann Mark, J D Bernal and others. A young lady with a camera rushed to get a photograph of von Laue wearing very brief swimming trunks. Seeing this Raman quipped to Ewald "She is trying to get the real Laue aufnahmen". Paul Ewald was so impressed with this spontaneous pun that he related this to many (including to me 6 years later when I was with him at Brooklyn Polytechnic).

The Indian Institute of Science

In 1933 Raman was appointed Director of the Indian Institute of Science (IISc). This Institute was set up in 1909 with the main objective of pursuing original research and providing advanced training in science and engineering. To J N Tata, the visionary, such an institution was to be the primary base for the intellectual rejuvenation and modernization of India. But to Lord Curzon, the then Viceroy of India, this was a seditious step against the British Raj and so he opposed its establishment. Nevertheless, five years after Tata's death, the IISc was established, and that too in Bangalore because of the farsightedness of the Maharajah and the Government of Mysore who offered it nearly 150 hectares of land and many other facilities.

The Directors of the Institute (till Raman's appointment) were always British and so were most of the earlier faculty. Some felt that under the tutel-

age of the British "Resident" of the Mysore State, IISc was subserving the interests of Great Britain, and that even the starting of the General Chemistry and Electrical Technology Departments were connected with the running of the British-owned Kolar Gold Fields.

"But such is the irresistible nature of truth that all it asks and all it wants is the liberty of appearing." What Thomas Paine said of truth is equally applicable to education. The effect of research and education "appearing" at IISc had a tremendous effect on the country. Nationalists however were dissatisfied with the "performance" of the institute — that in spite of large sums of money spent neither did the institute catalyze industrial growth nor did any outstanding scientific discoveries of which India could be proud, come out.

When Raman was to move to Bangalore it was said:

> "At present Calcutta may be regarded the centre of scientific research in India. With the transference to Bangalore of one of the leading investigators, Calcutta will have to guard its laurels."

Raman's invitation to German professors

The money spent on science in Calcutta was paltry compared to that spent at the Institute. Raman felt strongly (rightly or wrongly) that research and advanced education can be the foundation for any economic advancement only if there was excellence of the highest order. So Raman tried many strategies for bringing this about at IISc.

The first was to improve the surroundings (not just the houses of the director and the professors) by planting beautiful flowering trees — and in this he was aided by Sir Mirza Ismail, the Diwan of Mysore, and Mr Krumbeigel, the Chief Horticulturist of Lal Bagh.

The second was to set up a central workshop to make instruments (for it was Raman's view that no real progress in science can be made using *only* imported instruments). Precision instruments must be fabricated inside the country.

The third was to set an example of doing quality research. With a team of talented students he (again) blazed new trails in many fields — ultrasonic diffraction, Brillouin scattering, colloid optics, spectroscopic and optical properties of crystals, crystal transformations, X-ray topography and scattering, etc and put IISc on the scientific map of the world (some say for the first time in its 25 years of existence).

The final method was to fill important gaps in knowledge by recruiting outstanding faculty; Raman had a long list of subjects — some of these were: quantum mechanics (which was revolutionising physics); radioactivity (which was setting the pace in inorganic and biological chemistry); crystal chemistry (which was the basis for the development of modern materials so essential for India); vitamin and enzyme chemistry (which was making big waves in organic and biochemistry). Raman felt that the basic research in these fields will generate applications which would be important for India's development.

Max Born

It was at this time that many reputed scientists were fleeing Germany to escape the tyranny of Adolf Hitler — and Raman wanted to invite them to India:

> "I was not much in favour of young Indians going abroad to be initiated into scientific research. For if they are trained in a completely alien atmosphere not available in India the training may not prove useful. But if savants, seeking a country to adopt.are provided with a home we could start a great scientific movement."

It appeared to be an excellent idea as witness the renaissance of science in the United States which took place by the same process that Raman tried to adopt for India.

Raman first wrote to Schroedinger, the discoverer of wave mechanics, the physicist philosopher and author of *The Meaning of Life.* He replied saying that Raman's offer reached him after he had received and accepted another from Dublin, Ireland (although Raman's letter was posted earlier). Thus he has unfortunately "to miss the opportunity of being in the land of Upanishads".

Georg von Hevesy of the University of Freiburg, a pioneer in the use of radioactive tracers to follow chemical reactions and the movement of chemicals in human tissue, actually accepted the offer but did not come because of the later events related below.

For crystal chemistry V M Goldschmidt, perhaps the greatest authority in this field, was invited. He too accepted the offer but did not come probably for the same reasons.

Raman had many names on his list, both foreign and Indian, and it is a commentary on his choice that many of them (including Hevesy and Born) received the Nobel Prize many years later.

The visit of Max Born

Max Born was among the most outstanding theoretical physicists of this century. He developed the theory of atomic structure, worked on the early versions of the quantum theory (Bohr-Sommerfeld) and saw it blossom into quantum mechanics in the hands of Heisenberg.

Raman first requested Born to suggest the name of a young theoretical physicist for an appointment at IISc but later invited Born himself to spend six months to lecture here. Born and Mrs (Hedi) Born arrived in India in autumn 1935. Born had this to say of his first impressions:

> "We liked Lady Raman right from the beginning. When Raman appeared later we were fascinated by his appearance and talk. To Hedi he looked, in his Indian dress and turban, like a prince from *The Arabian Nights.*"

Max Born enjoyed his stay and his lectures were appreciated widely. To Lord Rutherford he wrote saying:

> "I must frankly say I like him (Raman) very much, inspite of his all too human drawbacks, his conceit and his naivete and therefore his disarming way of bringing himself into the light. I do not take these too seriously as I am finding (on the other hand) a genuine devotion to his work and to the Institute. He is an excellent physicist, full of optimism and activity and besides being interested in everything in the world."

Born interacted not only with Raman but also his students and all seem to have enjoyed it thoroughly. One of his student collaborators wrote of Born:

"It is amazing to speculate how

profoundly a great scientific mind can influence those coming in contact .... A most eminent physicist alike in the depth of mathematical power .... a teacher whose encouragement and kindness to his students is unparalleled."

And Lady Raman looked after their other activities. Born said:

"Life was pleasant for us; Hedi enjoyed it even more than myself. She met a Swami of the Ramakrishna Order and they became great friends. He told her that she had been an Indian woman in her previous incarnation because she understood Indian spiritual life so well."

So Raman decided to offer a permanent position to Max Born at the Institute. A selection committee was constituted and at Raman's suggestion Lord Rutherford was made a member Chairman (?) who had no difficulty in putting Born's name first among those recommended for selection. Rutherford conveyed this information to Born who decided to accept the offer:

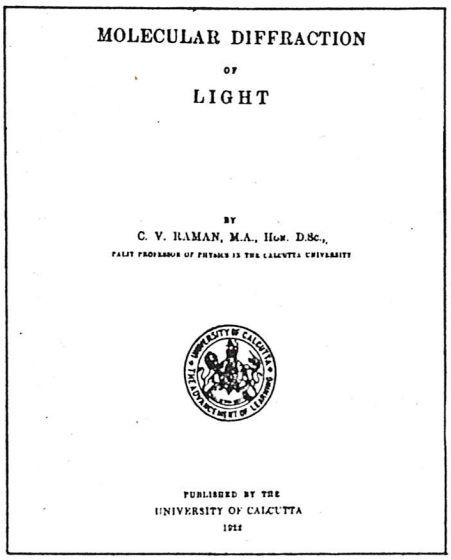
"While we would have liked to have had your services in Cambridge, I feel that the new position is not only very much better paid, but offers you an opportunity of influencing science in India. In this way I think you can exert a much wider personal influence for good than if you remained in Cambridge where you are one of a number and where possibly missionary work in the scientific field is not so important. Altogether, I feel you have made a wise decision."

All seemed to have been settled but.. . At the Council where this decision was to be ratified Raman spoke of the extraordinary merits of Born as a scientist, as a teacher, and as a human being. Then something quite unbelievable actually happened. An engineering professor from England who was rejected for an academic position even in England and whose name means nothing today even at IISc, spoke in the most derogatory fashion about Born — referring to him as a second-rater who had been driven out of his own country and one not good enough to be a member of the faculty of the Indian Institute of Science! So low had the British faculty at IISc descended.

After this public insult, of course, Born felt he could no longer accept Raman's offer and Raman too lost all hopes of rejuvenating the Institute in such a hostile atmosphere.

Why did Raman fail so miserably? There are many views expressed in this connection, some of which I quote. Born himself said:

"Raman came to the Institute with the idea of making it a centre of science of international standard. What he found was a quiet sleepy place where little work was done by a number of well-paid people ... Raman's speeding up of the entire pace of the Institute was bound to look like criticism of the former management. He made the heavy (sic) mistake in not waiting for a year or two before starting actual reforms."


MOLECULAR DIFFRACTION

OF

LIGHT

BY

C. V. RAMAN, M.A., Hon. D.Sc.,

PALIT PROFESSOR OF PHYSICS IN THE CALCUTTA UNIVERSITY

PUBLISHED BY THE
UNIVERSITY OF CALCUTTA
1918

Title page of the monograph "Molecular Diffraction of Light" by Raman

"Raman was obviously surrounded by people both British and Indian who largely looked upon IISc as a source of sinecure positions."

"Some of the English faculty resented working under Raman — an Indian — an experience they never had before."

"The faculty members had gained the ear of the colonial Government which agreed to put pressure on the Tata family."

"All changes made by Raman provoked resentment and many felt that physics was in the process of becoming a dominant feature of the Institute."

"Raman,far too conscious of his own superiority, made other people feel small in his presence."

"Raman with an astute mind and sharp tongue seemed to provoke resentment and tension round him."

"There is no Indian physicist of the rank of Raman. No man can compare with him in regard to vigour or intensity. This European intensity which Raman exhibited to a marked degree seemed to make many Indians suspicious of him."

Everything he tried to do was considered wrong and he had to resign his directorship (but retained his professorship at the Institute). It is a matter of great regret to many that Raman and Born who were such great friends fell out much later on a scientific issue. It is Born's view that the above regrettable incident rankled in Raman's mind which probably led to this unfortunate rupture.

The Raman Research Institute

Raman retired as Professor from IISc in 1948. He wanted to start a small institute for himself (the Raman Research Institute) where he could retire and "enjoy" doing science with a few collaborators. This he hoped to do with his life's savings; but it so happened that he lost most of his savings (including the Nobel Prize money) in a South Sea Bubble like investment. Undaunted, he proceeded and we see yet another European connection. He knew that while in most countries incandescent lamps were the rule, there were others in the East which still used kerosene and other lanterns and where lighting of streets in many cities was still done with gas (for example, Calcutta and cities in the Malay peninsula). With the aid of a student with a chemistry background he launched courageously into setting up a Welsbach mantle factory. Welsbach (1858-1929) discovered that a fabric soaked in thorium nitrate and cerium nitrate (both chemicals available in India) when heated glows with great brilliance. (Some of Raman's researches drew his attention to this fact.) The product from Raman's factory sold well, and the dividends from this venture were substantial. In fact they were sufficient to support his Institute and keep it independent at a time when he decided, for good reasons, not to accept even marginal support from Government.

The growth and the blossoming of the Raman Research Institute is another story.

Prof Ramaseshan is professor emeritus at the Raman Research Institute, Bangalore. A former Jawaharlal Nehru Fellow, he was also director of the Indian Institute of Science, Bangalore.