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SATURDAY, JULY 4, 1931

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Sir Chandrasekhara Venkata Raman

"RAMAN NUMBER"

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Corporation Ceremony

CORPORATION PRESENTS ADDRESS TO SIR CHANDRASEKHARA VENKATA RAMAN

CIVIC HONOUR FOR THE GREAT SCIENTIST

IN the historic Town Hall of Calcutta, elegantly decorated and illuminated, before a distinguished gathering, composed of some of the foremost citizens, the presentation of Corporation Address to Sir Chandrasekhara Venkata Raman on Friday, the 26th June, 1931, was a brilliant function.

The great scientist was, on arrival, received at the foot of the staircase by the Mayor, the Deputy Mayor and the Chief Executive Officer.

At the head of the staircase, Prof. Raman, who was accompanied by Lady Raman, was received by the Aldermen, Councillors and the principal officers of the Corporation, who followed in a procession. As he entered the Hall at the head of the procession, the whole assembly stood up and greeted him with cheers.

On reaching the 'dais,' the Mayor garlanded, amid applause, Sir Chandrasekhara, and as he took his seat, there was a shower of flowers upon him from an ingenious overhead contrivance. To Prof. Raman's right sat the Mayor, while to his left was seated the Deputy Mayor. Distinguished guests, Aldermen, Councillors and the principal officers of the Corporation occupied other seats on the 'dais.'

The Mayor then read the Address, which was printed on 'Khaddar' with gold embroideries, and presented on an engraved silver tray. The Address was received with applause by the assembly.

Sir Chandrasekhara, who on rising received an ovation, made a striking speech in the course of which he paid a tribute to Calcutta, which, he said, has been "the intellectual metropolis not only of Bengal, or of India, but of the whole of Asia from which has gone forth a living stream of knowledge in many branches of study."

At the end of the function the Mayor presented the Aldermen and Councillors of the Corporation to Sir Chandrasekhara.

Besides the Mayor, Aldermen and Councillors of the Corporation, the following among others attended the function :—

Sir P. C. Roy, Sir D. P. Sarvadhikari, Sir C. C. Ghose, Sir Nil Ratan Sircar, Mr. B. B. Ghose, Mr. Justice D. N. Mitter, Maharaja of Darbhanga, Lt. Col. A. D. Stewart, Sir Abdulla Suhrawardy, Mr. T. C. Goswami, Mr. Narendra Kumar Basu, Mr. Satyananda Bose, Capt. D. Ahmed, Messrs. R. N. Tagore, S. C. Roy, Brijlal Nehru, A. F. M. Abdul Ali, A. F. M. Rahaman, Rai P. N. Mukherjee, Bahadur, Dr. D. R. Bhandarkar, Dr. Edith Ghosh, Mr. and Mrs. Gagan Vihari Mehta, Dr. Narendranath Law, Diwan Bahadur, Dr. Hira Lal Basu, Mr. W. C. Wordsworth, Dr. W. S. Urquhart, and Mr. Satya Ranjan Bakshi.

The Corporation offices and schools remained closed on Thursday, the 2nd July, in honour of the presentation of the Corporation address to Sir C. V. Raman.

SIR C. V. RAMAN'S REPLY

Mr. Mayor, Aldermen and Councillors of the Calcutta Corporation, Ladies and Gentlemen :—

There are occasions when even the most cold-blooded of men finds himself deeply moved by emotion. It is possible that the ideal man of science should be just a perfect thinking machine with no sentiment or emotion in his make-up. That I am far indeed from approaching this ideal was evident on a certain occasion in Stockholm last December when the people of the coldest country in Europe tendered to a man of science from the tropic East the highest distinction in their gift. On the present occasion as well, I have difficulty in finding words in which to convey my feelings. Permit me, Sir, to express my gratitude to you and to your Fellow-Councillors for what must be regarded as a supreme honour by every citizen of Calcutta.

You, Sir, have referred to my early career. It is not often that the idealism of student days finds adequate opportunity for expression in the later life of manhood. It will soon be 25 years from the date of publication of my first research work. That the scientific aspirations kindled by that early work did not suffer extinction has been due entirely to the opportunities provided for me by the great city of Calcutta. To two men, especially, I owe a debt of gratitude that can never be repaid. It was the late Dr. Mahendra Lal Sircar, who, by founding the Indian Association for the Cultivation of Science, made it possible for the scientific aspirations of my early years to continue burning brightly. Dr. Sircar devoted a life-time of labour to the institution which he created and equipped in the hope that it would some day be utilised for the advancement of science in India. Its doors were open, awaiting the arrival of some one who could utilise the resources it offered. That arrival happened to be myself. Dr. Mahendra Lal Sircar did not, alas, live to see his aims accomplished. He sowed that others might reap. To another great citizen of Calcutta, a man who was most farseeing, profoundedly gifted and inspired by the highest ideals, I mean the late Sir Asutosh Mookerjee, I am also under a deep debt of gratitude. Sir Asutosh ventured to ask a young and unknown Government official to throw aside the preferments of office, and devote himself to the pursuit of knowledge under the aegis of the Calcutta University. This, on his part, was an act of great courage, whereas on mine it was just a case of following my own inclinations. But for the action which Sir Asutosh took, my scientific career would long ago have suffered an abrupt termination.

I desire to take this opportunity of expressing my gratitude also to my many friends in the city of Calcutta who have helped my work and made my task easier. Amongst them, I wish particularly to single out my distinguished friend, Sir Prafulla Chandra Ray, whom I am glad to see here to-day. I have always thought it a great privilege to have as my colleague in the Palit Chair of Chemistry such a distinguished pioneer in scientific research and education in Bengal as Sir Prafulla Ray. It has been invariably my experience that I could count on his co-operation and sympathy in every matter concerning my scientific work.

It has been my good fortune to have had during the past 15 years a long succession of highly gifted collaborators. To them, also, I am under a deep debt of obligation, for it is their assistance that has made possible much of the work that has

emerged from my laboratory. It is generally believed that it is the students who derive benefit by working under the guidance of a Professor. In reality, the Professor benefits equally by his association with gifted students working under him. From the very first, I have acted under the firm conviction that a Professor who succeeds in attracting and inspiring a group of co-workers was also benefiting himself and rendering to the cause of science far greater service than he could ever hope to offer in splendid isolation.

You, Sir, have referred to the fact that I never had any training in foreign laboratories or Universities. I believe myself that this was a fortunate circumstance, for it is my firm conviction that the highest inspiration for scientific work is that which comes from within oneself. It is my earnest hope that it will be possible in the near future to create opportunities in our own country for students to do the highest type of creating scientific work. In saying this, I do not for a moment suggest that we have nothing to learn from Europe or America, but surely it is better that we learn to accomplish whatever we can within our own borders.

You, Sir, have said that you desire my association with Calcutta to be a permanent one. Let me say at once that this is also my earnest desire. 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 Dehra Dun. 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 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 be able to work and live in such an environment.

Of recent years I have had occasions to visit numerous laboratories abroad. Many of them are being rebuilt or re-organised, in order better to cope with the problems of science. The Rockefeller Foundation has played the part of a fairy god-mother to many a scientist in Europe and America in the realisation of his scientific aims and aspirations. It is the Indian Association for the Cultivation of Science which first afforded me opportunities for scientific work at Calcutta, and which has been the scene of the labours of many of my most gifted collaborators. It is my earnest desire that its laboratory and library should be re-built and re-equipped so as to make their resources comparable with those of leading institutions abroad. If that desire were accomplished, not all the appointments in India joined together and offered to me as one gift would induce me to leave this great city.

Allow me to thank you once again for the great honour you have done me.

वन्दे मातरम् ।

To

Sir Chandrasekhara Venkata Raman,

Kt., M.A., Ph.D., D.Sc., LL.D., F.R.S.

Nobel Laureate in Physics.

Sir,

WE, the Aldermen and Councillors of the Corporation of Calcutta, beg to offer you our respectful congratulations on your great achievements in the domain of Science. The recent awards to you of the Nobel Prize, of the Royal Society's Medal and the Matteucci Medal, are, in each case, the first distinctions of the kind to be gained by an Asiatic man of Science, and bear unequivocal testimony to the high esteem and regard in which your contributions to knowledge are held in the world of Science. Working in an Indian Laboratory, with a purely Indian training, you have achieved results of the highest value, thus demonstrating the high level of efficiency attained by this country in the matter of scientific research.

Your single-minded devotion to the cause of Science and your bold idealism will ever remain a perennial source of inspiration to your countrymen. The highest academic degrees and the lucrative position in Government service, which you won at the early age of 18, would have satisfied most ambitions. But the passion for research, which had manifested itself even at that age, impelled you to seek opportunities for its further expression and led you to give up a lucrative career for the sake of Science. Your noble ideal and example have inspired the work of your pupils, and the *Indian Journal of Physics*, of which you are the founder, is the recognised organ for recording and stimulating research in Physical Science in this country.

It is not for us to narrate the long list of your contributions to Science, but we may be pardoned for mentioning the Raman Effect by the discovery of which you have secured a permanent place in the history of modern Science. New scientific truths, basing themselves on your epoch-making discovery, are emanating from the laboratories of every civilised country and continue to glorify your name.

As a great teacher of the youth of our country, you have exhibited in a remarkable degree a wide range of intellectual interests and a gift of exposition often touching the heights of humour and eloquence.

We recall with pride and pleasure that it was through one of our eminent fellow citizens that the creative genius of the East received the homage of the West when the Nobel Prize was attracted for the first time to Asia by the immortal works of our great national poet. We rejoice to think that by unravelling the deep mysteries of Nature, a most distinguished savant of this city has now brought to the East for the first time the highest award of the West in the field of Science.

Installed in the Palit Chair of Physics in the University of Calcutta, you have, by your success in extending the bounds of human knowledge, supplied some of the most enduring corner stones of the City's Temple of Learning. May you, by your continued efforts, shed further lustre on this City and bring greater glory to our Motherland, this ancient home of learning and knowledge.

We beg to subscribe ourselves,
Sir,
Yours in the service of the Motherland,
THE ALDERMEN AND COUNCILLORS OF THE
CORPORATION OF CALCUTTA,
by

Bidhan Chandra Roy

CALCUTTA,
The 26th June, 1931.

MAYOR.

Photo by T. P. SEN.

SIR C. V. RAMAN

In his office and private library at the Indian Association for the Cultivation of Science.

A Message to the Citizens of Calcutta

The "Calcutta Municipal Gazette", under the editorship of Mr. Amal Home, is today a power in the land. I, therefore, gladly agree to his request for a message to the Citizens of Calcutta to be published in its columns.

For nearly quarter of a Century, it has been my privilege to live and work in this great City, and I have learnt to love it as my home. The opportunities that have come to me to serve the cause of science and of our country are due to the efforts of two of Calcutta's greatest Citizens in the past — Dr. Mahendra Lal Sircar and Sir Ashutosh Mookerjee. To them and to many others happily still living, I owe a deep debt. May I express my gratitude?

C. V. Raman

SIR CHANDRASEKHARA VENKATA RAMAN

THE MAN AND HIS WORK

Early Life And Education

CHANDRASEKHARA Venkata Raman was born at Trichinopoly in South India on the 7th November, 1888, and is thus less than 43 years of age at the present time. His father, Mr. R. Chandrasekhara Iyer, was at that time a teacher in the S. P. G. College, Trichinopoly. When Venkata Raman was about four years old, Mr. Chandrasekhara Iyer was appointed Lecturer in Physics at Mrs. A. V. N. College, Vizagapatam. Mr. Chandrasekhara Iyer was of a scholarly temperament and fond of Mathematics and Physics. He was also an accomplished violinist. The next ten years of Venkata Raman's life was spent at Vizagapatam. The two persons who exercised the greatest influence on his early upbringing were his father and the late Mr. P. T. Srinivas Iyengar, who was a versatile scholar and then principal of Mrs. A. V. N. College. Venkata Raman was a precocious child and picked up very early a remarkable command of the English language. When he was seven years old, he came across an old copy of Paul Bert's "First year of Science" and read through it with avidity. Ganot's Physics followed. Although Venkata Raman was fond of Science and scientific experimenting and handicrafts like carpentry, he had a distaste for subjects like History and Sanskrit. In his class examinations, the neglect of these subjects sometimes gave him trouble.

For the first few years after coming to Vizagapatam Mr. Chandrasekhara Iyer was living in a house on the sea-coast between Waltair and Vizagapatam. He later moved to a house in the unhealthy part of Vizagapatam, and this told on the health of young Venkata Raman, which once broke down so completely that his life was despaired of. He, however, recovered but his health remained bad during the rest of his stay at Vizagapatam. Inspite of these handicaps, Venkata Raman passed his Entrance Examination at the early age of twelve and his First in Arts when he was fourteen.

Venkata Raman studied for his B. A. degree in the Presidency College, Madras. His tender age, keen intellect, enthusiasm for Science, and command of English soon attracted attention. He obtained the Elphinstone Prize for English essay. He passed his B. A. Examination with distinction in 1904, winning the first place in Physics and the Jagirdar of Arni Gold Medal. During these two years, Venkata Raman did not confine himself to the prescribed course of studies in Physics, but gave a good deal of attention to acquiring a firm grasp of fundamental subjects, like Dynamics and General Mathematics. After taking his B. A. degree, Venkata Raman continued his studies in the same college for his M. A. His passion for research work began to manifest itself and he asked for permission to carry on investigations instead of doing routine experiments. This was not agreed to. While doing some experiments with the spectrometer Raman noticed some peculiarities in the diffraction bands observed when light was reflected at a very oblique angle at the side of the prism. He went into the question thoroughly and arrived at a satisfactory explanation of the phenomenon. This formed the subject of his first scientific paper, which was published in the *Philosophical Magazine* in due course. Another investigation which he carried out successfully while still a student was the explanation of some curious observations by a fellow-student on the vibrations of strings.

At that time, the only superior service which was open to Indians of talent, and which did not require a stay in England for qualifying oneself, was the Indian Finance Department. Not seeing any possibility of a scientific career, Venkata Raman, on the advice of his Professors, decided to sit for the Competitive Examination of the Finance Department. Accordingly, he began to prepare for it during his second year M. A. course, reading books on Literature, Economics, History and other subjects. Raman sat for his M. A. degree Examination in January, 1907 securing a first class and obtaining record marks in his subject. He next sat for the Finance Examination in February, 1907 and here, again, secured the first place.

Raman began his life as an Assistant Accountant-General in Calcutta in June, 1907, and the next ten years of his life were spent as an officer of the Finance Department. Though the duties of his office took most of his time, his zeal for research work made Raman look out for opportunities for carrying on experimental investigations. While in Calcutta he discovered one day the Indian Association for the Cultivation of Science, and, having sought an interview with the late Mr. Amrita Lal Sircar, its Secretary (the son of Dr. Mahendra Lal Sircar, the founder of the Association), obtained permission to work in its laboratories during mornings and evenings out of office hours. Even when he was transferred out of Calcutta, first to Rangoon and then to Nagpur, Raman continued his investigations, converting part of his house into a laboratory and working with improvised apparatus. Fortunately, he was transferred back to Calcutta in November, 1911, and could again use the laboratories of the Science Association for his investigations. The steady stream of important original papers in acoustics coming out from the Association established Raman's reputation as an authority on that subject.

Raman's enthusiasm for scientific work and his success in original investigations despite the

(*Continued on page* 249.)

Twenty-Five Years Of Research

AS mentioned by Lord Rutherford on the occasion of awarding to Prof. Raman the Hughes Medal, "Sir Venkata Raman has made important contributions in many fields of research, and has also developed an active school of research in physical science in the University of Calcutta."

Prof. Raman's scientific activities began, as we have already seen, while he was still a student at college. The subjects of optics and acoustics in which he was interested at the time largely determined the direction of his later researches.

SOUND AND MUSICAL INSTRUMENTS.

During the years 1907-1917, while he was an officer in the Indian Finance Department, his researches chiefly dealt with the subject of vibrations and sound. Perhaps the most important contributions of this period relate to the theory of musical instruments. He studied the acoustical properties of the Violin, the Cello and the Pianoforte and also Indian stringed instruments such as the *Veena*, *Tanpura* and the Musical Drum or *Mridang*. His papers on the subject contain theoretical explanations of known facts concerning these instruments and also new results of great interest discovered by himself. He invented new instruments for studying noises and musical sounds and constructed a mechanical violin-player for physical experiments. Amongst his other works in this field may be mentioned his studies on the Whispering Galleries at St. Paul's Cathedral and the Victoria Memorial in Calcutta and the Granary at Patna. He is an acknowledged authority in the field of acoustics.

LIGHT AND COLOUR.

Prof. Raman is something of an artist in his appreciation of colour, and for the first four years after joining the Calcutta University in 1917, he largely engaged himself in inspiring his co-workers to investigate physical problems relating to the production of colour in Nature or in the laboratory by the modifications which light undergoes in its transmission around obstacles. One of the most notable papers of this period was the work done by his pupil, Dr. Bidhu Bhusan Ray, on the explanation of the coloured coronas and brocken-bows produced in the atmosphere by thin clouds or fog. The colours shown by the striae in mica, by mixed films of air and water, by colloidal sulphur in water, by chromatic mixtures and by liquid emulsions form the subject of some of the investigations of this period. The bending of light round edges and the interference rings observed in crystalline plates offered other more recondite problems. Another rather ambitious research was an endeavour to detect the change in the velocity of light in a tube 200 feet long containing flowing air. In the field of classical optics, Prof. Raman's researches entitle him to rank as a great authority. An account of the work done by him and his school appears in an article written by Prof. Laue for the "Handbuch der Experimental Physik."

THE BLUE OF OCEANIC WATERS.

A voyage to Europe during the summer months of 1921 gave Prof. Raman an opportunity of observing the wonderful blue colour shown by the Mediterranean Sea and by oceanic waters generally. As a student of optical science, the question of the cause of this phenomenon naturally challenged his attention, and gave a new direction to his scientific endeavours. Returning to Calcutta in September, 1921, he commenced experiments in order to discover the nature of phenomena produced when light traverses the substance of a transparent liquid like water. His discoveries opened up a new field of research of great importance, and were summarised in an essay on the "Molecular Diffraction of Light" published by the Calcutta University in February, 1922. During the following three years, Prof. Raman concentrated all his endeavours to working out the problems outlined in this essay. He showed that not only in liquids, but also in transparent solids, such as ice and quartz, light is scattered in consequence of the motion of the molecules. By measuring the intensity and character of the scattered light, it became possible to count the number of molecules in gases and liquids and to determine their movements. In the same way, the disturbances on the surface of liquids produced by the heat motion of its molecules could also be optically observed.

The scattering of light is a subject of great interest from the point of view of Chemistry. Every chemical molecule scatters light in its own characteristic way, which enables a substance to be recognised purely by optical observation from a distance. The relationship between molecular structure and properties and the power of scattering light occupied the attention of Prof. Raman and his pupils, and a great mass of data of importance to the Physical Chemist was accumulated by their work.

X-RAY STUDIES.

The optical investigations mentioned above indicated that liquids in general were not analogous in their constitution to gases or vapours as had been previously supposed, but are more similar in structure to solids. This induced Prof. Raman to undertake an investigation of the structure of liquids by means of X-rays. The patterns observed when a narrow pencil of X-ray passes through a film of liquid, and is received at a distance on a photographic plate, reveals the structure of the liquid, and it was shown that this was in accordance with the expectations from the optical experiments. Prof. Raman and his co-workers carried out an examination of the X-ray patterns of an immense number of liquids, liquid mixtures and solutions, and obtained results of the highest value to Physics and Chemistry. The method of X-ray analysis has also been applied in Prof. Raman's laboratory to the study of crystal structure and of colloidal substances.

MAGNETIC RESEARCHES.

Prof. Raman's interest in optical science naturally led him to the study of the optical behaviour of substances when placed in strong magnetic fields. Here also his instinct for scientific discovery rapidly led him to important results. It had

long been known that certain liquids when placed in a magnetic field exhibit a feeble double refraction similar to that of crystals. By greatly increasing the sensitiveness of the experimental arrangements, Prof. Raman was able to detect such magnetic birefringence in a great many substances in which it had not been noticed previously. Further, it was shown how, by interpreting these observations, the magnetic properties of the molecules could be inferred. Some molecules, such as benzene, were magnetisable with very different strength in different directions. Others, on the other hand, showed nearly uniform magnetisability in all directions. The results indicated a new and unsuspected connection between chemical constitution and magnetic behaviour.

In order to confirm this new knowledge, studies on the magnetic behaviour of the substances in the crystalline state were undertaken. The results obtained though very surprising were fully in accord with expectation.

Delicate measurements on the magnetic properties of substances are now a regular feature in Prof. Raman's laboratory. Amongst the many interesting discoveries made under his inspiration, may be mentioned the remarkable one that the magnetic behaviour of substances may in some cases be altered merely by powdering them finely and diminishing the size of their particles.

OTHER INVESTIGATIONS.

Besides the special fields of research mentioned above in which he is an authority, Prof. Raman has touched many other topics, and seems to find no difficulty at all in entering into almost every branch of Physics. The researches published from his laboratory include subjects so diverse as the theory of elasticity and impact, observations on percussion figures, surface tension and surface-movements, waves and ripples, convection of heat, the nature of fluid viscosity, kinetic theory of gases, electrical properties of molecules, photo-elastic phenomena, luminescence of solids, spectroscopy and radio-active haloes. Many a man of science has made his reputation by specialising in one or other of the numerous fields mentioned. But to Prof. Raman, they all seem to come very easily. His scientific interests indeed extend far beyond the region of Physics into those of the sister sciences of Chemistry and Mathematics. Much of his research work has been inspired by a desire to understand the fundamental basis of chemical phenomena. Being both a theoretical and experimental physicist, he is also interested in higher Mathematics.

HIS GREATEST DISCOVERY.

The Raman Effect has not so far been mentioned as it deserves an article all by itself. Though the paper in which this discovery was published is only one of his numerous publications during a quarter of a century, it stands out from all others by reason of the enormous interest which it has evoked. In view of this, the nature of the Effect and how it came to be discovered are described separately. We may well hope that though up to the present it is his greatest work, it may be surpassed in the future.

THE LATE SIR ASHUTOSH MOOKERJEE

Prof. Raman's Tribute

Sir C. V. Raman, who presided at the meeting held at the Calcutta University Institute on the 29th June to celebrate the birth anniversary of Sir Ashutosh Mookerjee, spoke as follows :—

"We are celebrating to-day the birthday anniversary of that great man, not so much with feelings that were present in our mind and oppressed us when we were face to face with the great loss which his death meant to us. But to-day we are inspired by greater feelings which shall move us year after year for a long time to come—feelings of joy that it was given to us to have such a great man as one of us.

"The truest signs of the greatness of a man, lie in the universality of appeal which his character and achievements possess. It does not infrequently happen that an individual appears to be a remarkable person to a small group or a small community. It is not infrequent in a province like Bengal, which seems to produce outstanding talents in large numbers, to find men, who have a very special appeal to particular areas and particular times in which they happen to be. But I believe that one of the essential signs of Sir Ashutosh's true greatness lies in the fact of the universality of appeal of his remarkable character, his remarkable personality and his remarkable achievements. They appeal to men of very different races, very different creeds and very different outlook.

"Sir Ashutosh's greatness, it seems to me, has shown itself in other ways. It is easy to impress one who has no great culture and learning himself. It is easy to convey impression of knowledge to those who have no knowledge. But it is difficult to impress those who have a high standard of judging the works of others. But the remarkable thing about Sir Ashutosh was that men of learning and culture and of the highest character were impressed by his greatness. His power of influencing them was remarkable. That has marked him out as a great man. The great moving force of his life was to offer opportunities for the highest kind of study and research. There is no doubt that it was his desire to offer such opportunities to the many young men whom the Calcutta University produces. The greatness of Sir Ashutosh's achievements lies, not only in the fact that he has been able to leave an impress of his personality on the Calcutta University, but also lies in the fact that that impress has spread far beyond the limits of the University of Calcutta and, to-day, has spread over the whole length and breadth of India."

"At the present time," Sir C. V. Raman further observed, "we Indians are passing through an epoch full of hopes and fears, an epoch full of conflicts and reconciliations. We are passing through an epoch of the creation and destruction of ideals. We are passing through very difficult times and it is difficult for us—for even the most courageous of prophets—to know where we are going. At such a time it is profitable to have Sir Ashutosh's ideals before us."

The Raman Effect: What Is It?

WE shall now try to explain what the Raman Effect is—using simple language. It may be stated in a single sentence: the colour of light may be changed by scattering. But if the full meaning of this statement is to be understood, we have to enter into some explanations. Ordinary white light, as we receive it from the sun or from the incandescent filament of an electric bulb, is composite and consists of many colours, which may be separated by passing the light through a glass prism. The rainbow-like band of colours thus obtained is called a spectrum. A rough surface, such as a piece of white cloth or paper, scatters light, which in the process remains substantially unaltered. If white light falls on a piece of coloured cloth or paper, part of the spectrum is absorbed within the substance and the remaining part is scattered, and there is an *apparent* change of colour, but not a real one. This is readily shown by examining the spectrum of the scattered light, which will be found to be the same as that of the originally used white light, only with certain colours weakened or cut off. No essentially new colours are produced in this common kind of scattering of light at the surface of opaque bodies. To observe the Raman Effect, we have to study the light *entering into a substance* which is transparent, or at least not wholly opaque, and *emerging again from its interior* after being scattered by its molecules. Further, one must start by using not white light, but monochromatic light, that is, light of one single colour. This is allowed to enter the substance under study and emerge again after scattering within its volume. In order to observe fully what happens, it is necessary to examine the spectrum of the scattered light by a prism of "spectroscope" as it is called. It is then found that the spectrum of the scattered light is not identical with the spectrum of the light first used, but contains in addition to the original colour or ray, also other colours or rays. These new rays are actually produced by the action of the molecules of the substance; when they scatter the incident light, they act upon it and cause it in part to change into new colours or rays.

The discovery of the Effect was not an accident, but was the result of prolonged and patient researches extending over a period of nearly seven years. These researches began in the summer of 1921, when, during the voyage made on the occasion of his first brief visit to Europe, Prof. Raman's attention was strongly attracted to the beautiful blue colour exhibited by the waters of the deep sea. On his return to India, he inaugurated an extensive series of experimental and theoretical studies of the scattering of light by the molecules of transparent media such as air, water or ice. We have a familiar instance of such scattering in the blue light of the sky which consists of sunlight diffused by the molecules of the air. Sky-light appears, when not very carefully examined, to have the same spectrum as sunlight; its colour is due to the blue rays of the spectrum being scattered by the molecules more strongly than the red rays and, therefore, more conspicuous in the final result. The molecules of water and other liquids, and of such solids as ice, quartz or glass similarly scatter light without any apparent change. The experiment of Professor Raman and his pupils, however, revealed that there was also present in the scattered light something which was different from the incident light. Step by step, the investigations led to the recognition of the true nature of the phenomenon and the discovery of what is now known as the Raman Effect.

The essentials for the study of the Raman Effect are *firstly*, a strong source of "monochromatic" light, such as is conveniently furnished by an electric mercury vapour lamp, *secondly*, the substance which may be anything,—gas, liquid or solid, which is not too opaque and is, therefore, capable of internally scattering light, and *thirdly*, a spectroscope with which the spectrum of the scattered light may be observed or photographed.

That the new rays or colours observed in the Raman spectra of scattered light are really due to a change in the colour of the incident light is proved by the fact that if we use an incident ray of different colour, the new rays or colours observed in the scattered light are also different. On the other hand, the substance used plays an essential part in the phenomenon, for the number and position in the spectrum of the new rays observed depend on substance used and are characteristic of it.

The Raman rays furnish the physicist and the chemist with a very simple and powerful method of examining the ultimate constitution of the substance studied. They are capable of furnishing answers to a great variety of questions arising in Physics and Chemistry, and of yielding an apparently inexhaustible wealth of information regarding the structure of molecules and their behaviour under all possible conditions. The great interest aroused by the discovery has led to its being widely taken up as a tool of research and stimulated the leading instrument-makers of the world to design and construct new spectographs of great power for the study of the Effect. In every civilised country and in almost every University research laboratory, studies of the Raman Effect are being carried on, and some 600 original papers on the subject have already appeared in the literature. It would be impossible to summarise, in a paragraph or two, the great mass of interesting information contained in these publications. If one single consequence of the Raman Effect may be selected for special mention, it is the fact that it conclusively demonstrates the corpscular or particle-like nature of light. The Raman Effect has built new bridges between the sciences of Physics and Chemistry, and helped us to solve many of the deepest problems of modern science.

The

Indian Association For The Cultivation Of Science, Calcutta

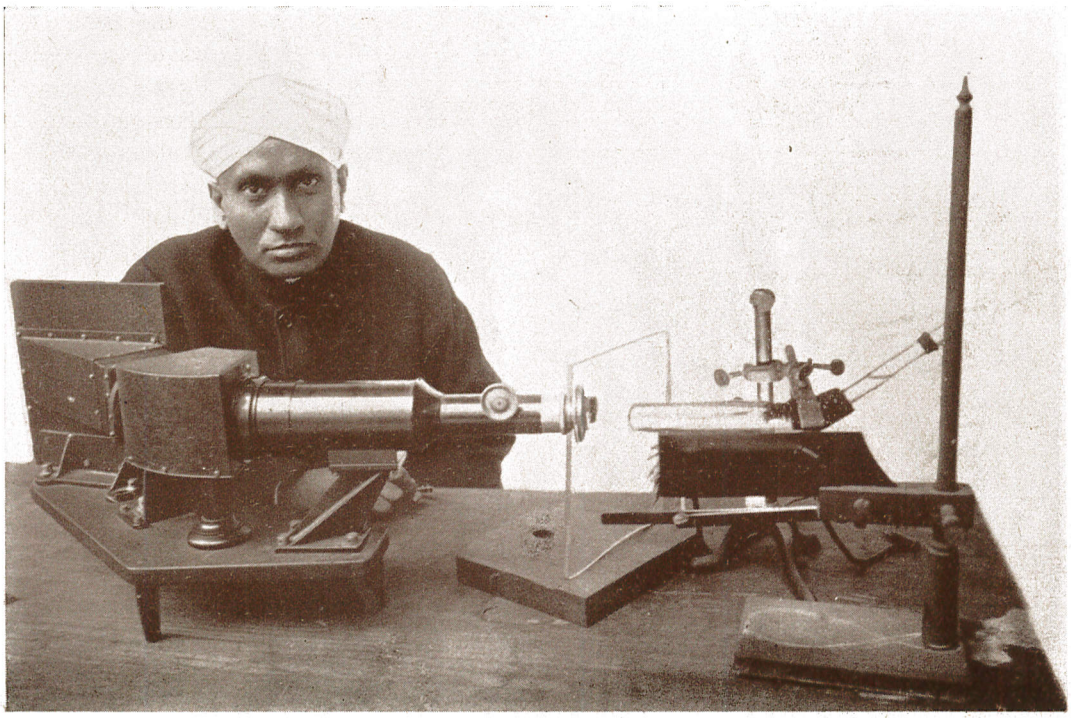
WHICH HAS BEEN THE HOME OF SIR CHANDRASEKHARA'S WORLD-RENOWNED RESEARCHES

1. ENTRANCE TO LECTURE HALL.
2. VIZIANAGRAM RESEARCH LABORATORY.

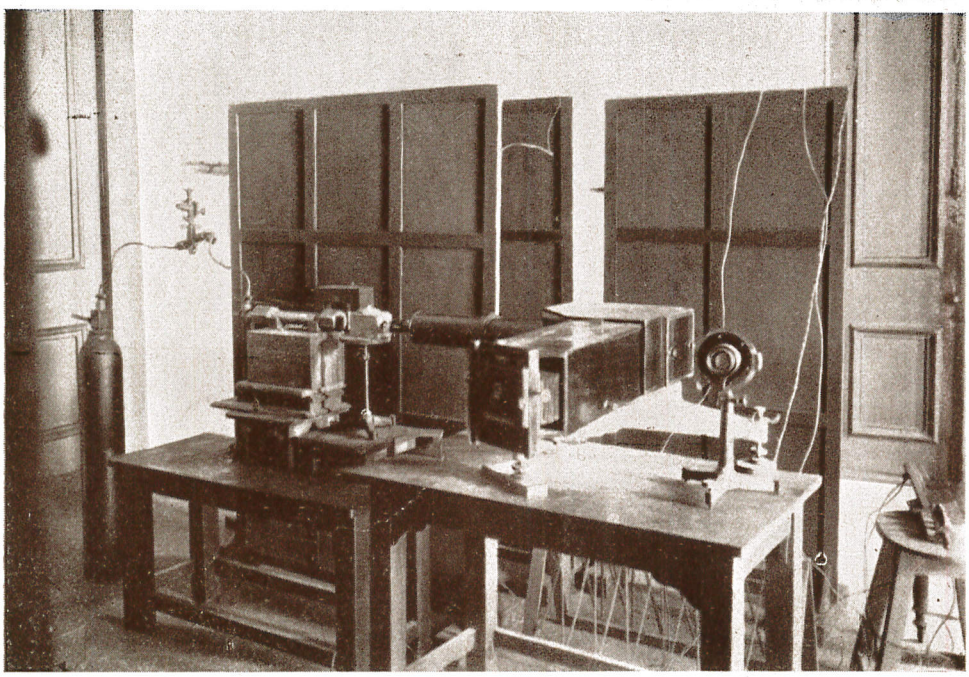
The

Indian Association For The Cultivation Of Science, Calcutta

WHICH HAS BEEN THE HOME OF SIR CHANDRASEKHARA'S WORLD-RENOWNED RESEARCHES



SIR C. V. RAMAN WITH HIS "RAMAN EFFECT" APPARATUS



A ROOM IN THE RESEARCH LABORATORY

Apparatus for photographing Raman Effect in Gases.

The Home Of Prof. Raman's Researches—Indian Association For The Cultivation Of Science, Calcutta.

DR. MAHENDRA LAL SIRCAR.
From a marble bust at the Indian Association For the Cultivation of Science.

ONE of the most important events in the history of scientific advance in India was the foundation in 1876 of the Indian Association for the Cultivation of Science in Calcutta. It was the creation of a great man, the late Dr. Mahendra Lal Sircar, who, for many years, laboured to bring it into existence and to establish it on a secure foundation. Dr. Sircar's life-work was inspired by his passionate belief in intellectual activity and especially the pursuit of science as a method of national regeneration. He intended that the Association should be a centre of scientific research from which would flow out a stream of living knowledge. He hoped that the institution created by him would achieve a position comparable to that of the great scientific institutions and academies of the West. But these high aims did not bear fruit during Dr. Sircar's life-time, and he died, a deeply disappointed man, in the year 1904.

Prof. Raman's connection with the Indian Association for the Cultivation of Science goes back now nearly quarter of a century. As we have already seen, shortly after his arrival in Calcutta as an Officer in the Indian Finance Department in June, 1907, he discovered the Association. It might be said that at the same time the Association discovered him, for he has been the means of achieving the aims for which it was founded. At the time his connection with it began, the fortunes of the Association were at a low ebb. For 30 years the institution had done useful work in popularising scientific knowledge by the delivery of elementary lectures in Physics, Chemistry and Botany. But with the steady increase in the number of colleges sufficiently equipped for elementary work of this kind, the Association was losing its hold on the student world, and it was clear that its lectures would soon be no longer required. With the coming of Raman, the activities of the Association took an entirely new direction towards scientific research. His contributions were issued in the form of Bulletins, and made the Association known abroad. Steadily, its scientific prestige and influence grew.

A further era of development commenced in 1919, when, on the death of Mr. Amrita Lal Sircar, Prof. Raman resigned the Vice-Presidentship of the Association and took executive charge as Honorary Secretary. His scientific reputation attracted teachers and students from all parts of India to Calcutta to work under his direction in the laboratory of the Association, and the output of research greatly increased in consequence. The "Proceedings" of the Association, later issued as the *Indian Journal of Physics*, secured for the work of the Association a scientific audience throughout the world. The reputation of the Association as a scientific centre grew up and now stands very high. The growth of the scientific activities of the Association has naturally involved heavy recurring expenditure, and this has given Prof. Raman much work and anxiety. In addition to his scientific activities, he has constantly to face the problem of how to make both ends meet. Added to these difficulties is the fact that the laboratory of the Association, built and equipped forty years ago, is entirely out-of-date and unsuited for the requirements of modern research. The library, which has been added to considerably of recent years, has also out-grown the existing accommodation. The necessity of re-building and re-equipping the laboratory and library of the Association to suit present-day needs is manifest, and is, it is gratifying to note, occupying the attention of Professor Raman.

— Early Life And Education—*contd.*

(Continued from page 245.)

many handicaps, could not fail to attract the vigilant eye of the late Sir Ashutosh Mookerjee, the then Vice-Chancellor of the Calcutta University. When the Palit Endowment Fund was created, and Sir Ashutosh wanted a Professor capable of organizing and directing research to fill the chair of Physics, he naturally thought of the young Finance Officer and offered him the post. Although Raman knew that from a pecuniary point of view he would be a great loser, he did not hesitate to make the sacrifice, but accepted the offer. Raman left Government Service in July, 1917, and joined the University of Calcutta.

Prof. Raman – Founder Of An Indian School Of Physics.

PROF. Raman's position in the world of science to-day depends on the fact that he has not only himself been an investigator of the first rank, but has also inspired a whole group of men whose work has firmly established the reputation of Calcutta as a centre of research. The ten years from 1907 to 1917 represented a period during which his duties in the Finance Department claimed most of his time, and only the little leisure available was used for his personal investigations. The call to the Calcutta University in July, 1917, freed him from the bondage of official work and enabled him to devote attention to the training of a long succession of students in the laboratories of the University College of Science and of the Indian Association for the Cultivation of Science. An idea of the influence Prof. Raman has exerted in building up an Indian School of Physics may be obtained by mentioning some of the Physicists who, at one time or other, worked in Calcutta in these two institutions and now occupy independent scientific positions.

Indian Meteorological Department.

Dr. Sudhansukumar Banerji, Director, Colaba Observatory, Bombay.

Dr. Bhabonath Banerji, Meteorologist, Karachi.

Dr. K. R. Ramanathan, Meteorologist, Poona.

Dr. Nalini Kanta Sur, Meteorologist, Poona.

Dr. Suresh Chandra Roy, Meteorologist, Poona.

Dr. L. A. Ramdas, Meteorologist, Poona.

Mr. B. N. Srinivasiah, Assistant Meteorologist, Agra.

University of Calcutta.

Dr. Phanindra Nath Ghosh, Professor of Applied Physics.

Dr. Sisir Kumar Mitra, Professor of Physics.

Dr. Bidhu Bhusan Roy, Lecturer in Physics.

Dr. B. N. Chuckerbutti, Lecturer in Physics.

Mr. D. Banerji, Lecturer in Physics.

Dr. Panchanan Das, Professor, Howrah College.

University of Dacca.

Prof. S. N. Bose, Professor of Physics.

Dr. Nalini Mohan Basu, Professor of Mathematics.

Mr. K. S. Krishnan, Reader in Physics.

University of Allahabad.

Prof. M. N. Saha, F.R.S., Professor of Physics.

Dr. Rajendra Nath Ghosh, Lecturer in Physics.

Mr. D. B. Deodhar, Lecturer in Physics.

University of Patna.

Mr. D. B. Deodhar, Lecturer in Physics. Patna College.

Dr. I. Ramakrishna Rao, Professor, B. N. College.

Hindu University of Benares.

Dr. B. Dasannacharya, Professor of Physics.

Dr. C. M. Sogani, Professor of Physics.

University of Agra.

Dr. Nihal Karan Sethi, Professor, Agra College.

Mr. V. S. Tamma, Principal, Meerut College.

Mr. L. Srivastava, Professor, Ajmere College.

University of the Punjab.

Dr. V. I. Vaidyanathan, Lecturer, Forman Christian College.

Dr. Goverdhanlal Datta, Professor D. A. V. College, Lahore.

University of Nagpur.

Dr. A. S. Ganesan, Lecturer, Science College.

Mr. R. S. Deoras, Lecturer, Science College.

Mr. V M. Dabadghao, Lecturer, Science College.

Chidambaram University.

Dr. S. Ramachandra Rao, Reader in Physics.

Bombay University.

Mr. W. M. Dabadgho, Professor of Physics, P. B. College, Poona.

University of Rangoon.

Mr. N. C. Krishnaiyar, Professor of Physics.

Dr. R. Venkateswaran, Lecturer in Chemistry.

University of Madras.

Dr. J. C. Kameswar Rav, Professor, Nizam's College, Hyderabad.

Patents Department.

Mr. S. Venkateswaran, Examiner of Patents.

Mr. K. Seshagiri Rao, Examiner of Patents.

In addition to his research work, Prof. Raman also regularly lectures to the Post-Graduate classes in Physics at the University. At the invitation of the Indian Science Congress, and of the Indian Universities, he has frequently delivered public lectures on recent advances in physical science at various centres. The stimulus of his lectures has been in no small degree responsible for the development of scientific research in India at the present time.

"LOST CITY" FOUND.

Ruins of Maya Civilization.

Cutting through thirty-five miles of dense bush, through the top of which roared a mighty wind, with below scarcely enough air to breathe, was one of the obstacles surmounted by Captain T. A. Joyce, of the Department of Ethnography of the British Museum, who has returned to London after an expedition in British Honduras.

Captain Joyce's trips will throw further light on the mystery of the lost Maya civilization. His party explored hitherto unvisited ruins up the South Stanu Creek River. Here they discovered a series of mounds and pyramids forming two large courts, formerly, it is thought the site of altars and temples, wrought by the ancient Mayas.

Among many finds was a stone spear, bearing a lengthy, dated inscription, which, when translated, it is believed, will prove of the utmost value; a coffin fashioned out of solid slate; two perfect stone axes and a stone knife.

"We also found pieces of the beautiful pottery, which the ancient Mayas fashioned," said Capt. Joyce, in an interview, "an ear ornament made of jadite, incense burners, and other relics of that remarkable civilization which flourished round about 300 or 400 A.D."

Prof. Raman's Latest Researches

SINCE his recent return from Europe, Sir C. V. Raman has been carrying out a number of scientific experiments.

In the course of an interview he said that the most important research work now being carried out under his direction related to the fundamental nature of light.

According to the generally accepted views at the present time, Sir C. V. Raman explained, light possesses a dual character, namely, the nature of a wave motion as also its corpuscular or particle-like properties. Every moving particle possesses energy and momentum, and it has long been known that light possesses both of these characters. That it has energy is shown by the convertibility of light into heat and mechanical motion. That light has momentum is a consequence of the theory which is confirmed experimentally, by the fact that it exerts a pressure on any surface on which it falls and by which it is absorbed or reflected.

The experimental demonstration of radiation pressure, continued Sir C. V. Raman, is one of the great triumphs of 19th-century Physics, and it is recognized at the present time that the momentum of light plays a fundamental part in cosmic phenomena. There is another important attribute of light in regard to which there has been considerable uncertainty. The question arises whether light possesses a spin or an angular momentum, similar to that of a top or a gyroscope, or that of a bullet shot from a gun with rifled bore.

The wave-theory of light seems to indicate that light may possess an angular momentum in some cases and may not possess it in others. The newer theories, on the other hand, indicate that light also always has a spin, though whether the spin is left-handed or right-handed may be indeterminate in some cases. There has, so far, been no definite experimental proof whether light possesses an angular momentum or not.

The question, continued Sir C. V. Raman, now appears to be definitely decided by the researches made in his laboratory by himself and his collaborator, Mr. S. Bhagavantam. The researches indicate that light invariably possesses an angular momentum. In other words, light consists of particles which have the threefold attributes of energy, momentum and a spin.

The experimental proof of this, he concluded, is furnished by scattering light in gases and determining its state of polarisation before and after such scattering. Molecules possess a spin or an angular momentum of their own, and when they collide with the light-particles, an exchange of spins may occur. Whenever a molecule gains or loses spin, it is found that light changes from a right-handed to a lef-handed character or *vice versa*. This proves that the light-particle itself possesses a spin which may be left-handed or right-handed, according to circumstances.

Prof. Raman's Publications

SIR C. V. RAMAN published his first original paper in the *Philosophical Magazine* of London in the year 1906, when he was still a student at the Presidency College, Madras. At that time, and for several years subsequently, there was no Indian periodical suitable for the publication of research work in Physics, and he was in consequence obliged to submit his work to foreign periodicals or learned societies. That a very different position exists to-day is due to Sir C. V. Raman himself. The *Indian Journal of Physics*, which is conducted by him on behalf of the Indian Association for the Cultivation of Science, has been made possible by his energy and by the generous support of the Calcutta University aided by the co-operation of the University Press. The important position occupied by the *Indian Journal of Physics* is indicated by the fact that the paper for which the Nobel Prize was awarded to him was published in its pages. The Journal was first issued under its present name in 1926. The *Proceedings of the Indian Association for the Cultivation of Science*, of which it is a continuation, began its career in 1915 and is now running in its fifteenth annual volume.

Some of Sir C. V. Raman's earlier contributions appeared as Bulletins of the Indian Association for the Cultivation of Science. Bulletin No. 15 is a bulky memoir extending to some 158 pages dealing with the theory of musical instruments of the violin family. It is widely quoted as an authoritative work.

Another notable publication is his essay on the "Molecular Diffraction of Light" extending to 103 pages published by the Calcutta University Press in February, 1922. This essay exercised a great influence on the development of the subject, and is a forerunner of the work for which the Nobel Prize was awarded.

The German Physical Society decided in 1926 to issue a great work running into 24 volumes under the title *Handbuch der Physik* as a complete encyclopaedia of contemporary Physics. For this series, only one author outside the German-speaking countries in Central Europe was invited to contribute, and that was Sir C. V. Raman. His article on the theory of musical instruments appeared in the 8th Volume of the *Handbuch*, and incorporates much of his personal research work on the subject.

(*Continued on page* 253.)

Sir C. V. Raman In Sweden

RECEPTION BY THE SWEDISH-BRITISH SOCIETY AT THE GRAND HOTEL, STOCKHOLM

AT THE TECHNICAL SCIENTIFIC SOCIETY, GOTEBORG

Prof. Raman's Travels Abroad

PROF. RAMAN visited Europe for the first time during the summer months of 1921, in order to attend the Congress of the Universities of the British Empire held at Oxford in that year. He toured in England and Scotland, visited several Universities and made many friends amongst British men of science. He also lectured before the Physical Society of London. He returned to Calcutta in September, 1921.

His next visit to Europe was in May, 1924, after he had been elected as a fellow of the Royal Society of London. He was invited by the British Association for the Cultivation of Science to visit Canada, and opened a discussion on the Scattering of Light at Toronto. After attending the meeting of the Association and of the International Congress of Mathematics at Toronto, he travelled across Canada to Vancouver and back again. He then proceeded to Philadelphia where he represented India at the Centenary of the Franklin Institute. From thence he travelled across the United States to Pasadena at the invitation of Prof. R. A. Millikan to accept a visiting Professorship at the California Institute of Technology. He lived at the Faculty Club of the Institute from September to December, 1924, and lectured regularly to American teachers and students on the Thermodynamics in March, 1925, visiting *enroute* some of the Univer- in March, 1925, visiting *enroute* some of the Universities in Norway, Sweden, Denmark and Germany.

He had again to proceed to Europe in August, 1925, at the invitation of the Russian Academy of Sciences to be present at the celebration of its Bicentenary. Travelling *via* Italy, Austria, Germany and the Balkan States to Russia, he attended the celebrations at Leningrad and Moscow, and then went across Russia and over the Caucasus Mountains to Tiflis University in Georgia. He returned *via* Baku on the Caspian Sea to Moscow and Leningrad, and then over the Baltic sea to Germany, Switzerland and Italy. He returned to India in November, 1925.

The Faraday Society of London organized a General Discussion at Bristol in September, 1929, on the subject of Molecular Structure and Molecular Spectra. One of the three sections into which the discussion was divided was the Raman Effect, and of this, C. V. Raman was nominated as the opener. He left for Europe early in August, 1929, and travelled *via* Italian and French Rivieras, reaching England in time to attend the meeting at Bristol. Numerous invitations to lecture were received by him from Universities and learned societies in Great Britain and the Continent. After fulfilling as many of these engagements as could conveniently be accepted, he returned to Calcutta in December, 1929.

The fifth and last visit to Europe was made to receive the Nobel Prize at Stockholm on the 10th of December, 1930. Leaving India soon after the news of the award came in, Stockholm was reached on the 9th of December. After a week spent in the Nobel festivities, visits were made and lectures delivered at Upsala and Goteborg in Sweden, Oslo in Norway, Copenhagen in Denmark and Munich in Germany. After visiting Strasburg University *en route*, Glasgow was reached on the 15th January in time for the Honorary Graduation Ceremony. France, Switzerland, Italy and Sicily were also visited *en route* to India which was reached in February.

Lady Raman accompanied her husband on the last two occasions.

—Prof. Raman's Publications—*contd.*

(*Continued from page* 251.)

Though Prof. Raman's literary activities now-a-days centre round the *Indian Journal of Physics*, he is an occasional contributor to the columns of *Nature*, the well-known weekly scientific periodical issued in London. As a mark of respect to the Royal Society of London, of which he is a Fellow, he also occasionally contributes to the Proceedings of the Society. The earlier volumes of the *Philosophical Magazine*, the *Physical Review*, the *Proceedings of the Physical Society of London*, the *Proceedings of the Optical Society of London*, the *Journal of the Optical Society of America* and the *Astrophysical Journal* contain numerous papers contributed by himself and the Calcutta school of Physics.

He has been repeatedly pressed to write treatises describing the subjects in which he is specially interested. But it is always more attractive for a man of his temperament to undertake new researches than to spend time in writing up afresh the results of already completed work.

SCHOOLBOOKS FROM UR.

R-WRITING CITY LIFE OF 4,000 YEARS AGO.

There are now being unpacked in the cellars of the British Museum 30 large cases which Mr. Leonard Woolley has taken back from Ur of the Chaldees. They contain clay bricks inscribed with cuneiform records of ordinary events in Ur 4,000 years ago.

There are (said Mr. Woolley in an interview) schoolbooks, tradesmen's accounts, love letters, and all kinds of writings. From them he hopes to find out who lived in each house, what they did for a living, and to make, in fact, a complete directory of the city dating from its final desertion in about 2,000 B. C. In an old school kept by a priest, 2,000 inscribed tablets were found. The schoolmaster had about 12 pupils, who were taught mathematics and geometry and wrote literary composition. The compositions were generally written on round tablets, and ordinary lessons on rectangular ones. Some of these school exercise "books" are 18 in. across, and an attempt will be made to piece together the whole school curriculum. In another house it was found that the owner was a grain merchant, a money-lender, and a dealer in ready-made clothing. There was a "letter" to him from a commercial traveller in a distant country, who complained that he had written five times before and had no reply.

THE HUGHES MEDAL

AWARDED TO SIR C. V. RAMAN BY THE ROYAL SOCIETY, LONDON

(Obverse)

(Reverse)

International Appreciation Of Prof. Raman's Work

TO a man of science, the Nobel Prize constitutes the most appreciated distinction, and its conferment on Sir C. V. Raman in 1930, will naturally, therefore, be regarded as securing for him the highest attainable honour in the world of science. There are, however, other distinctions which he has received, which are well worthy of record and in reality not less significant.

Almost simultaneously with the Nobel award (but a week earlier and, therefore, independently of it) the Hughes Medal and premium for 1930, was awarded to Sir C. V. Raman by the Royal Society of London. The award is, according to the Year-Book of the Society, made to "such person as the President and Council may consider the most worthy recipient, without distinction of sex or nationality, as the reward of original discovery in the Physical Sciences." The list of Hughes Medallists in earlier years includes several Nobel Laureates. The "Societa' Italiana Delle Scienze" of Rome awarded the "Matteucci" Medal in 1928, for the discovery of the Raman Effect, thereby classing its author with the most eminent physicists of the age. The Nobel Prize, the Hughes Medal and the "Medaglio Matteucci" were all for the first time awarded to an Asiatic Scientist in the person of Sir C. V. Raman.

The following Universities have conferred Doctorates on him; Calcutta University, Hon. D. Sc. in 1922; Freiburg University, Hon. Ph. D. in 1929; Glasgow University, Hon. LL.D. in 1930. During the current year, the Universities of Bombay and of Dacca have announced their intention of conferring on Prof. Raman the Hon. LL. D. and Hon. D.Sc., degrees respectively.

Prof. Raman was elected a Fellow of the Royal Society of London in 1924. He has received the Fellowship or Honorary Fellowship of numerous other learned societies in India and abroad, amongst the most coveted of which may be mentioned, the Honorary Fellowships of the Physical Society of Zurich, (1929) and of the Royal Philosophical Society of Glasgow (1931). He was General President of the Indian Science Congress in 1928. He was appointed for a session in 1924 as Visiting Professor at the California Institute of Technology at Pasadena in the United States, a position, which has been held by distinguished physicists of international standing such as, Lorentz, Einstein, Sommerfeld and Bjerknes. He has lectured by special invitation before the leading physical societies, such as those of England, France, Belgium and Switzerland, before the British Association for the Advancement of Science, and before numerous foreign Universities such as those of Cambridge, London, Edinburgh, Paris, Stockholm, Oslo, Copenhagen, Munich, Freiburg, Leningrad, Moscow, Toronto, Stanford, Iowa and so forth.

Innumerable tributes to the importance of the work of Sir C. V. Raman have been paid by eminent men of science of all nations. We shall be content with quoting just one of them. Lord Rutherford in announcing the award of the Hughes Medal by the Royal Society, said that "Sir Venkata Raman is one of the leading authorities on optics, in particular on the phenomenon of the scattering of light. In this connection, he discovered that the light's colour could be changed by scattering. The Raman Effect must rank among the best three or four discoveries in experimental physics of the last decade. It has proved and will prove an instrument of great power in the study of the theory of solids. In addition to important contributions in

(Continued on page 257.)

The Nobel Prize For Physics—List Of Winners

ALFRED Nobel, the Founder of the Nobel Prize, was born at Stockholm in 1833. He went to Russia in 1842, and assisted his father in the construction of submarines and mines and torpedoes, and in the manufacture of explosives, more particularly nitro-glycerine. In 1857 he took out a patent for a gasometer, and in 1859 for an apparatus for measuring liquids, and also an improved barometer. In 1866 he invented the explosive compound dynamite. From the manufacture of dynamite and his inventions of smokeless powder and artificial India-rubber, Nobel amassed a large fortune, which he left for the foundation of five annual prizes, of about £8,000 each, to be awarded for the most important discoveries in (1) Physics, (2) Chemistry, and (3) Physiology or Medicine; for (4) the most remarkable work in Literature of an idealistic tendency, and for (5) the greatest service to the cause of Peace during the year. The benefits of the Foundation are open to all nationalities without restriction even of sex. The first four are awarded by the Swedish Academy, and the fifth by the Norwegian Storthing.

Below are reproduced the names of the winners of the Nobel Prizes in Physics :—

1901.

The prize for the year 1901 was awarded to :—

RONTGEN, WILHELM CONRAD, Professor of Physics at the University of Munich, born 1845, died 10th February, 1923; in recognition of "the exceptional services rendered by him in the discovery of the special rays, which have been called after him."

1902.

The prize for the year 1902 was divided equally between :—

LORENTZ, HENDRIK ANTOON, Professor of Physics at the University of Leyden, born 1853, died 5th February, 1928 and

ZEEMANN, PIETER, Professor of Physics at the University of Amsterdam, born 1865; in recognition of the "special services rendered by them in their investigation regarding the influence of magnetism upon the phenomena of radiation."

1903.

The prize for the year 1903 was divided equally between :—

BEQUEREL, HENRI ANTOINE, Professor of Physics at the *Ecole Polytechnique;* born 1852, died 25th August, 1908; in recognition of "the special services rendered by him in the discovery of spontaneous radio-activity." The other half was divided equally between :—

CURIE, PIERRE, Professor of Physics at the *Ecole municipale de physique et de chimie industrielles* in Paris, born 1859, died 19th April, 1906; and his wife,

CURIE, MARIE SKLEDOWSKA, Professor at the *Ecole Normale superieure des jeunes filles* in Sevres, born 1867; in recognition of "the special services rendered by them in the work they jointly carried out in investigating the phenomena of radiation discovered by Professor Henri Bequerel."

1904.

The prize for the year 1904 was awarded to :—

RAYLEIGH, LORD (John William Strutt), formerly Professor of Natural Philosophy at the Royal Institution of Great Britain in London, born 1842, died 1st July, 1919; "for his investigations into the density of the most important gases, and for his discovery of argon in connection with these investigations."

1905.

The prize for the year 1905 was awarded to :—

LENARD, PHILLIP, Professor of Physics at Kiel University, born 1862; "for his work in connection with cathode rays."

1906.

The prize for the year 1906 was awarded to :—

THOMSON, JOSEPH JOHN, Professor of Experimental Physics at the University of Cambridge, born 1856; "in recognition of the great services rendered by him in his theoretic and experimental investigations regarding the passage of electricity through gases."

1907.

The prize for the year 1907 was awarded to :—

MICHELSON, ALBERT ABRAHAM, Professor of Physics at the University of Chicago, born 1852, died May, 1931; "for his optical instruments of precision, and the spectroscopic and meteorologic investigations, which he carried out by means of them."

1908.

The prize for the year 1908 was awarded to :—

LIPPMANN, GABRIEL, Professor of Physics at the University of Paris, born 1845, died 12th July, 1921; "for his method, based upon the phenomenon of interference for reproducing colours by photography."

1909.

The prize for the year 1909 was divided equally between :—

MARCONI, GUGLIELMO, born 1874; and

BRAUN, FERDINAND, Professor of Physics at the University of Strasbourg, born 1850; died 20th April, 1918; "in recognition of their services in the development of wireless telegraphy."

1910.

The prize for the year 1910 was awarded to :—

VANDER WAALS, JOHANNES DIEDERIK, formerly Professor of Physics at the University of Amsterdam, born 1837, died 8th March, 1923; "for

his work in connection with the equation of state for gases and liquids."

1911.

The prize for the year 1911 was awarded to :—

WIEN, WILHEM, Professor of Physics at the University of Wurzburg, born 1864, died 31st August, 1928; "for his discoveries regarding the laws governing the radiation of heat."

1912.

The prize for the year 1912 was awarded to :—

DALEN GUSTAF, Chief Engineer, Stockholm, born 1869; "for his discovery of automatic regulators, which can be used in conjunction with gas accumulators for lighting lighthouses and light buoys."

1913.

The prize for the year 1913 was awarded to :—

KAMERLINGH, ONNES HEIKE, Professor at the University of Leiden, born 1853, died 21st February, 1926; "in recognition of his investigation into the properties of matter at low temperatures which led, amongst other things, to the production of liquid helium."

1914.

The prize for the year 1914 was awarded to :—

VON LAUE MAX, Professor at the University of Frankfort-on-Main, born 1879; "for his discovery of the defraction of Rontgen rays on passing through crystals."

1915.

The prize for the year 1915 was divided equally between :—

BRAGG, W. H., Professor at the University of London, born 1862 and his son :—

BRAGG, W. L., Professor at the Victoria University of Manchester, born 1890; "for their services in the analysis of crystal structure, by means of X-rays."

1916.

The prize for the year 1916 was allocated to the special fund for this group of prizes.

1917.

The prize for the year 1917 was awarded in 1918 to :—

BARKLA, CHARLES G., Professor at the University of Edinburgh, born 1877; "for his discovery of the characteristic Rontgen radiation of the elements."

1918.

The prize for the year 1918 was awarded in 1919 to :—

PLANCK, MAX, Professor at the University of Berlin, born 1858; "in recognition of the services rendered by him to the development of Physics, by his discoveries in connection with the quantum theory."

1919.

The prize for the year 1919 was awarded to :—

STARK, JOHANNES, Professor at the University of Greifswald, born 1874; "for his discovery of the Doppler effect in Canal rays, and of the decomposition of spectrum lines in an electric field."

1920.

The prize for the year 1920 was awarded to :—

GUILLAUME, CHARLES EDOUARD, Sevres, born 1861; "in recognition of his services to the physics of precision by his discovery of anomalies in nickel steel alloys."

1921.

The prize for the year 1921 was awarded in 1922 to :

EINSTEIN, ALBERT, Professor, Berlin, born 1879. The prize was awarded to Einstein independently of such value as may be ultimately attached to his theories of relativity and gravity, if these are confirmed, "for his services to the theory of Physics, and especially for his discovery of the law of the photo-electric effect."

1922.

The prize for the year 1922 was awarded to :—

BOHR, NIELS, Professor of Physics at the University of Copenhagen, born 1885; "for his services in the investigation of the structure of atoms, and of the radiation emanating from them."

1923.

The prize for the year 1923 was awarded to :—

MILLIKAN, ROBERT ANDREWS, Professor at Pasadena (California), born 1886; "for his works on the elementary charge of electricity, and on photo-electric phenomena."

1924.

The prize for the year 1924 was awarded in 1925 to :—

SIEGBAHN, KARL MANNE GEORG, Professor of Physics at the University of Upsala, born 1886; "for his discoveries and investigations in X-ray spectroscopy."

1925.

The prize for the year 1925 was divided equally in 1926 between :—

FRANCK, JAMES, Professor of Physics at the University of Gottingen, born 1882 and

HERTZ, GUSTAV, Professor of Physics at the University of Halle, born 1887; "for their discovery of the laws governing the impact of an electron upon an atom."

1926.

PERRIN, JEAN, Professor of Physical Chemistry at the University of Paris, born 1870; "for his works on the discontinuous structure of matter, and especially for his discovery of the equilibrium of sedimentation."

1927.

The prize for the year 1927 was divided equally between :—

COMPTON, ARTHUR HOLLY, Professor of Physics at the University of Chicago, born, 1872;

(*Continued on page 257.*)

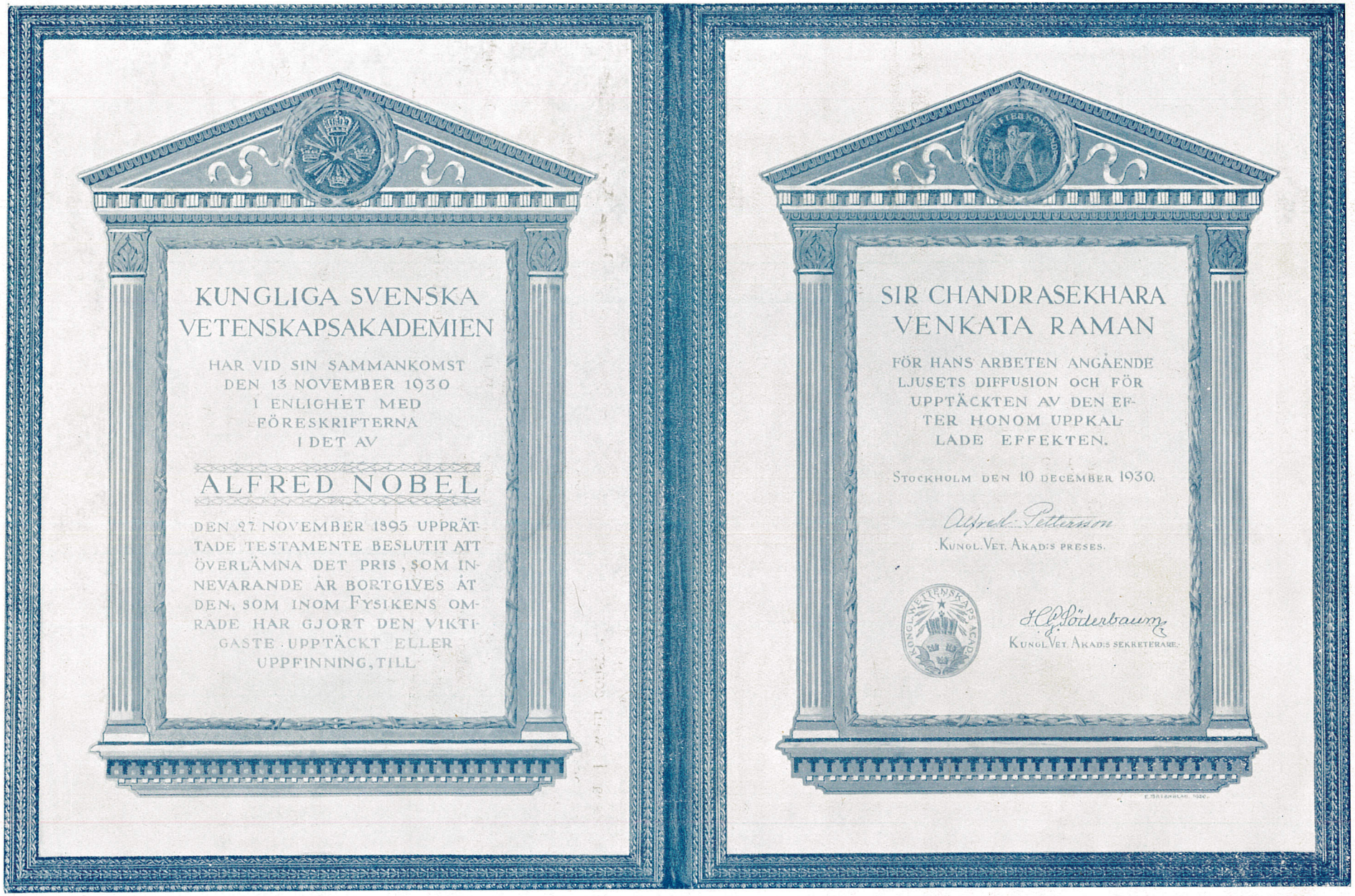
THE NOBEL PRIZE DIPLOMA

(OUTER SIDE)

Bound in deep blue grained morocco leather with gold work, the outer side or the cover of the Nobel Prize Diploma is really a work of art.

THE NOBEL PRIZE DIPLOMA

(INNER SIDE)



Hand-painted and hand-lettered in colours on vellum of very superior quality with gold embroidery on deep blue leather, the inner side of the Nobel Prize Diploma is of exquisite workmanship—simple, elegant and beautiful.

The Nobel Prize For Physics—Its Significance

ALFRED NOBEL, an imaginative and inventive Swedish Chemical Engineer, earned a fortune by his numerous successful applications of nitro-glycerine and nitro-cellulose to the manufacture of explosives. In his last will, dated the 27th November, 1895, a year before his death, he left property worth about 31 million kronen "to constitute a fund, the interest accruing from which shall be annually awarded in prizes to those persons who shall have contributed most materially to benefit mankind during the year immediately preceding. The said interest shall be divided into five equal amounts to be apportioned as follows:— One share to the person who shall have made the most important discovery or invention in the domain of Physics; one share to the person who shall have made the most important chemical discovery or improvement; one share to the person who shall have made the most important discovery in the domain of Physiology or Medicine; one share to the person who shall have produced in the field of Literature the most distinguished work of an idealistic tendency; and finally one share to the person who shall have most or best promoted the fraternity of Nations and the Abolishment or Diminution of standing armies and the Formation and Increase of Peace Congresses . . . I declare it to be my express desire that in the awarding of prizes no consideration whatever be paid to the nationality of the candidates, that is to say, that the most deserving be awarded the prize, whether of Scandinavian origin or not."

The object of Nobel in making his will was to place those who had devoted themselves to scientific research with conspicuous success without regard to personal gain, in a position of such complete independence that in future they could devote their whole energies to their work. In some respects, it was not possible to adhere to a strict literal interpretation of the will. An important scientific discovery is often the result of a continued series of investigations extending over a number of years. It takes time to test it and even to appreciate its proper value. The same remark applies even more strongly to literary work or efforts towards international peace. The administrators of the fund have, therefore, exercised a freedom of choice not restricting themselves to work done "in the previous year," but taking into full consideration all scientific discoveries or inventions, or works of literature or efforts towards international peace and goodwill which have contributed most materially to benefit mankind. The prize has now become an award for achievement.

Going over the list of previous Nobel Prize-winners in Science, it is easy to see what qualities in a scientific discovery or invention are considered to be necessary in order that the discoverer or inventor may be considered worthy of the honour. The list of Nobel Prize-winners in Physics and Chemistry include such name as J. J. Thomson, Rutherford, Marconi, Michelson, Einstein, Bohr, Millikan and Aston. The discovery should undoubtedly be of a fundamental and far-reaching character, and its truth clearly established by experiment. It is of no importance whether it is immediately applicable to practical purposes or not. Of the 35 names in the list of Nobel Prize-winners in Physics only six are those of purely theoretical physicists; and in their case also, the award was postponed until experiments had established the truth and generality of the laws of nature which they had propounded. For example, Planck developed his quantum theory to explain the facts of radiation as early as 1900, but was awarded the Nobel Prize only in 1919. Einstein was awarded the prize not for his theories of relativity and gravitation but for his other services to the theory of Physics, and "especially for his discovery of the law of photo-electric effect." Workers in the Applied Sciences like Astrophysics, Geophysics, or Engineering do not generally come in for a share, the only exceptions being the pioneers in wireless telegraphy, Marconi and Braun and the Swedish Engineer, Dalen.

—International Appreciation Of Prof. Raman's Work—*contd.*

(*Continued from page* 254.)

many fields of knowledge, he has developed an active school of research in physical science in the University of Calcutta."

Amongst Prof. Raman's Indian distinctions may be mentioned, the Honorary Membership of the Indian Mathematical Society, the Fellowship of the Asiatic Society of Bengal and the Honorary Membership of the Patna Medical Association.

—The Nobel Prize For Physics—*contd.*

(*Continued from page* 256.)

"for his discovery of the phenomenon known by his name"; and

WILSON, CHARLES THOMSON REES, Professor at the University of Cambridge, born 1869; "for the method discovered by him of perceiving by condensation of steam, the paths taken by electrically charged particles."

1928.

The prize for the year 1928 was awarded in 1929 to:—

RICHARDSON OWEN WILLIAMS, Yarrow Professor of the Royal Society, for his work on the emission of electrons from hot bodies, and his discovery of the law governing the phenomenon.

1929.

The prize for the year 1929 was awarded to:—

DE BROGLIE, PRINCE LOUIS VICTOR, Professor of Physics in the Sorbonne, for his discovery of the wave-like nature of the electron.

1930.

The prize for the year 1930 was awarded to:—

RAMAN, SIR CHANDRASEKHARA VENKATA, Professor of Physics at the University of Calcutta, for his investigations on the scattering of light and the discovery of the effect known after him.

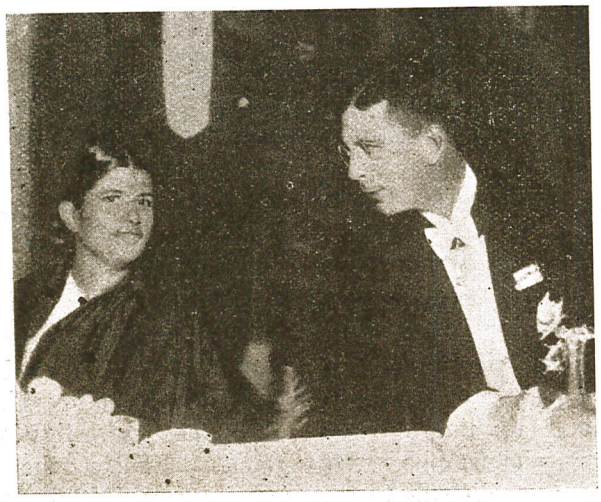
renunciation of Buddha, the Royal ascetic and world-teacher and of his message of non-violence and love which embraced all living creation. It was nearly twelve when the party broke up.

Next day, the Nobel lectures were delivered at the University. Each prize-winner spoke on his own work. These lectures are later collected in the form of a book. In the evening, there was a reception by the King and Queen at the Palace. After dinner, the guests were shown round the library and art collections and time passed pleasantly in conversation with various members of the Royal family. We met there a grandson of Tolstoy who kindly took us to various places of interest. The 12th December was a very very cold day. A chill wind was blowing. On the night we witnessed an interesting popular local festival called *Lucia-light*. There was a procession led by a young maid with a crown of lighted candles on her head. The legend was that she was heralding the advent of snow and was bringing light for the dark winter days ahead. Strangely enough, when we woke up next morning, there was a sheet of white snow all over the city greatly enhancing its beauty. Next to Venice, Stockholm is considered to be the most beautiful city in Europe, with its large clear fresh-water lake in its centre, magnificent buildings on the shores of the lake and its clean, broad streets.

As we had few further social engagements, we walked that morning some distance out of the city to enjoy the beauty of the snow scenery. The snow had transformed, as if by magic the dark artificially lit city and surroundings into a scene of ethereal beauty.

Next day, we were invited to dinner at the house of the President of the Swedish Academy, Dr. Petterson. It appears that when the poet Rabindranath Tagore was there, he sang some Indian songs and the memory of it was still fresh in their minds. Somehow, they induced my husband also to sing.

After one more day of leisured sight-seeing, we left for Upsala on the 16th, where we were the guests of Prof. Siegbahn and his lady.



Lady Raman and the Crown Prince of Sweden at the Nobel Banquet.

TRY

To raise a new city, a beautiful city where the roads will sparkle, and the parks and open spaces will be a perennial green; a city which will teach the three R's to every street-boy and bring health and succour to the diseased and the needy; and, above all, a city which will, from day to day, animate, through the very atmosphere it creates, the meanest of its citizens with the prospect of a useful, generous and expansive life before him.

Sir C. V. Raman And The Nobel Prize

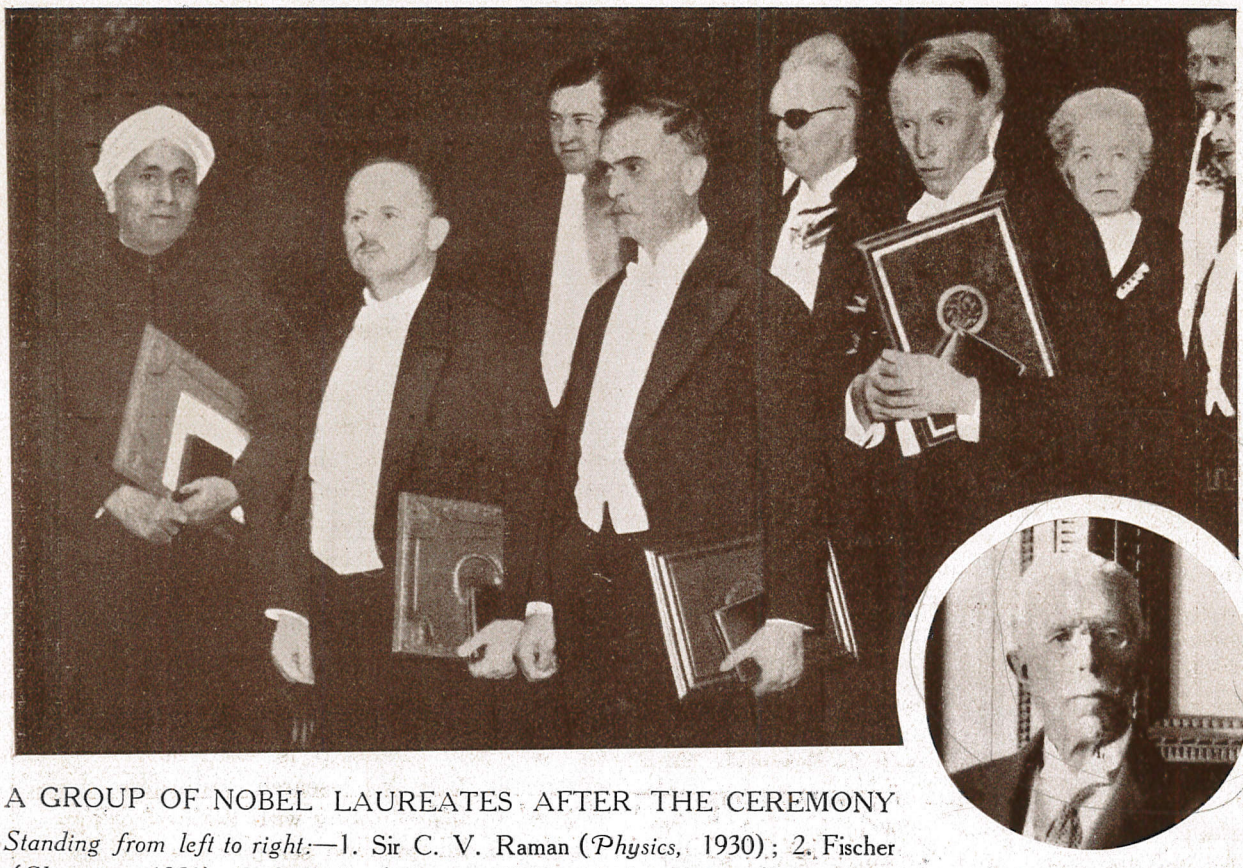
THE NOBEL PRIZE AWARD CEREMONY, STOCKHOLM, 1930

A portion of the audience gathered at the great Orchestra Hall of Stockholm on December 10, 1930 to witness the award of the Nobel Prizes for the year. The King of Sweden and the Royal Family in the front row.

SIR C. V. RAMAN RECEIVING THE PRIZE

The entire assembly stood up as Sir C. V. Raman received the Prize from the hands of the King of Sweden.

Sir C. V. Raman And The Nobel Prize



A GROUP OF NOBEL LAUREATES AFTER THE CEREMONY

Standing from left to right:—1. Sir C. V. Raman (*Physics*, 1930); 2. Fischer (*Chemistry*, 1930); 3. Siegbahn (*Physics*, 1924); 4. Landsteiner (*Physiology*, 1930); 5. Dalen (*Physics*, 1912); 6. Sinclair Lewis (*Literature*, 1930); 7. Selma Lagerlof (*Literature*, 1909).

The Nobel Laureates of 1930 will be seen carrying the Nobel Diploma and Medal in their hand.

Inset—THE KING OF SWEDEN

THE NOBEL BANQUET

The award of the Nobel Prize ceremony was followed by a banquet, presided over by the King of Sweden, in the great hall of the Mela at Stockholm.

Science And Calcutta

[BY SIR CHANDRASEKHARA VENKATA RAMAN, Kt., M.A., Ph.D., D.Sc., LL.D., F.R.S.]

WHETHER a great and populous city offers the most suitable environment for the pursuit of scientific research may well be questioned. Many instances may be cited which seem unfavourable to the supposition. That the centre of gravity of Science in Great Britain is to be found at Cambridge and not in London or Edinburgh is probably no accident. The Mecca of Physicists in the United States of America is not New York or Chicago but the charming little town of Pasadena which nestles in the Californian valley within sight of the celebrated observatory on Mount Wilson. In Germany, again, while Berlin can boast of distinguished men of science—including Einstein—as its Professors, the most active schools of research, where ambitious students congregate, are those at Gottingen, Leipzig and Munich. In the smaller towns, life is less expensive, there is less noise and bustle and greater freedom from the numerous distractions which a great city offers. It is not surprising, therefore, that distinguished scholars often fight shy of great cities and prefer to pursue their studies in more placid surroundings.

It would be folly, however, to believe that Science can only flourish in monastic seclusion away from the surge of human life. Nothing could be further from the truth. Science derives her strongest impulses from the desire to serve human needs as well as from the purely philosophic desire to understand Nature more deeply. Hence, to be in touch with life, to understand the claims for service made by Humanity, and to attempt to satisfy them, makes for true scientific progress. Further, Science cannot do without libraries and laboratories, and she must have the means to free her votaries from the necessity of otherwise earning their daily bread. If Science chooses to live and work in seclusion, she runs the risk of losing the sympathy of those who can provide her with resources. Thus, Science and Humanity need each other, and they both can flourish only when their obligations to each other are understood and discharged.

In view of what has been said, it is not surprising that at least in some great centres of human life, we do also find flourishing schools of scientific research. Paris is a typical example of a great city which is not only the political and social but also the intellectual capital of its country. Calcutta claims a similar privilege so far as Bengal is concerned, but an impartial observer would probably also concede without hesitation that the proud privilege she once enjoyed of being the Imperial Capital has not yet disappeared in the sphere of scientific activity. She owes her prestige and influence in the sphere of learning to her century-old tradition of culture and research, to the long line of eminent scholars, both Indian and European, whom Calcutta has numbered and numbers among her citizens, and not least to the efforts of such men as the late Dr. Mahendra Lal Sircar and Sir Ashutosh Mookerjee, who strove to create the facilities for higher studies and research that others now enjoy.

Conceding the fact that Calcutta exercises a leadership in scientific research which extends far beyond the limits of the Province of Bengal, it must be a matter of pride and personal concern to every one of her citizens to see that such leadership is maintained for the future. The price to be paid for scientific leadership is very heavy. Ceaseless experimentation and research, utilization of the best available talent, working with the best of appliances, even if it involves the scrapping of earlier equipment, these are some of the needs of Science, and they all mean expense. The generosity of Sir Taraknath Palit and Sir Rashbehari Ghosh enabled Calcutta to give a lead to the other cities of India in the matter of higher scientific studies and research. If that lead is to be maintained, new efforts are necessary, and they are only possible if Calcutta and her citizens feel some pride and responsibility in the matter and are prepared generously to support scientific research. Judged by Indian standards, Calcutta is a wealthy city, but it must be remembered that at present it is only an infinitesimal position of her wealth which finds its ways to the channels which can fructify genuine scientific research. If the value of scientific research and the benefits which it can confer on the community are adequately realised, more generous support, I am sure, will be forthcoming.—Reprinted from the Sixth Anniversary number of the *Calcutta Municipal Gazette*.

COUNCILLOR GEO. MORGAN.

Re-Elected To Improvement Trust.

The Bengal Chamber of Commerce has re-elected Mr. George Morgan, C.I.E., M.L.A., (Messrs. Morgan Walker and Co.) to be their representative on the Board of Trustees for the Improvement of Calcutta.

PAIKPARA LIBRARY.

Third Anniversary.

The third anniversary of the above Library was held at the Paikpara Raj Bati, Ward 31, on the 28th of June, 1931, at 6 p.m. with Rai Bahadur Dr. Dinesh Chandra Sen, in the chair. The Prize Essay on "Influence of Literature on Society" by Mr. Mohendra Lal Saha Ray, M.A., was read out. He and Miss Parul Das Gupta, the best essayist amongst women competitors were awarded two medals. Kaviratna Dwijendranath Chaudhuri, Vidyabinode, Sahityaratna, delivered a short speech on the subject which was highly appreciated by all present. The President in his address dwelt at length on the aesthetic spirit running through Bengali literature with special reference to the painting and dancing of Bengal and the ballads of Mymensing. With a vote of thanks to the chair offered by Mr. Nalini Mohan Chatterjee, Councillor, Calcutta Corporation, the meeting terminated late at night.

DR. M. A. ANSARI

CORPORATION PRESENTS WELCOME ADDRESS

DR. M. A. ANSARI.

The Corporation of Calcutta presented an Address of Welcome to Dr. M. A. Ansari of Delhi at the Town Hall on Tuesday, the 30th June. The function was very largely attended.

The Corporation Offices and Schools remained closed on Thursday, the 2nd July in honour of the presentation of the Address to Dr. Ansari.

The text of the Address and the full text of Dr. Ansari's reply will appear in the next issue of the *Gazette*.

HOUSE DRAINAGE—NEW CONNECTIONS.

The following house drainage plans showing new sewer connections were sanctioned during the week ending 27th June, 1931 :—

Districts	Premises No.	No. of connections.	Date of connection.
I	85, Chitpur Road, Upper ...	1	23-6-31
	8, Shibu Biswas Lane ...	1	25-6-31
	30, Mohan Bagan Lane ...	1	25-6-31
	137 & 137-1, Cornwallis Street	1	25-6-31
II	8B, Crouch Lane ..	1	26-6-31
III	14, Chakrabere Lane ..	1	23-6-31
	2, Munshi Bazar Road ...	1	23-6-31
	16, 16-1, Shibtolla Lane (Bustee).	1	25-6-31

ROADS CLOSED FOR REPAIR.

Name of Roads.	Probable date of commencement.	Probable date of completion.
STONE ROAD.		
Gorapada Sarkar Lane, W. 28 ...	5-7-31	15-8-31
Beliaghatta Main Road between Canal Bridge and Railway Bridge, W. 29.	5-7-31	3-9-31
BRICK ROAD.		
Bahir Surah Road between Surah East Road and Radha Madhab Dutta Garden Lane.	5-7-31	15-8-31

DELHI MUNICIPALITY

Health Department

Sealed tenders of rates are invited and will be received by the undersigned on or before 12 noon of 10th July, 1931, for new rat traps, the particulars of which are given below :—

1. Type—"Wonder Rat Trap."
2. Material—Steel wire.
3. Total length of the rat trap—15 inches.
4. Size of steel wire—16 guage.
5. Length of Posterior chamber—8 inches long.
6. Length of Anterior chamber—7 inches long.
7. Girth (circumference) should be 2 feet 6 ins. and shape. 
8. Binding with quadruple wire single binding.
9. The traps must be of strong built.
10. Number of rat traps required—3,000 (about).
11. The automatic closing door between the 2 chambers to be of proper shape, size, weight and correctly balanced.
12. The supply to be made at the Municipal Bullock Depot, Delhi (free delivery charged).
13. The supply to be made by instalment or in one lot within a month of receipt of the orders for the supply.
14. A sample trap should be forwarded with the tender.

K. S. SETHNA,

Dated 29th June, 1931. *Medical Officer of Health.*