



# DREAM 2011

October 2002

Vol. 5

No. 1

## VP News

### SAARC Book Fair In Dhaka

Vigyan Prasar participated in the first SAARC Book Fair 2002 held at Dhaka, Bangladesh, during 26-29 September 2002 under the aegis of SAARC Book Development Council, representing National Publishers' Associations of the SAARC countries. The venue of the Book Fair was Shilpakala Academy in Dhaka and it



*Shri V.K. Joshi and Dr. Subodh Mahanti presenting some Vigyan Prasar publications to Begum Selima Rahman, Hon'ble Minister of State of Cultural Affairs, Govt of the People's Republic of Bangladesh.*

was organized by Bangladesh Publishers' Council. The Fair was inaugurated by Begum Selima Rahman, Hon'ble Minister of State of Cultural Affairs, Govt of the People's Republic of Bangladesh. Publishers from, Bangladesh, India, Nepal, Pakistan and Sri Lanka participated in the Fair. Seventeen Publishers from India Including Vigyan Prasar and Publications Division, Govt. of India took part in the fair. The closing ceremony was graced by Hon'ble Foreign Minister of Bangladesh Mr. M. Morshed Khan. Vigyan Prasar's books were well appreciated by the visitors at the Fair. Publishers from other foreign countries showed keen interest in Vigyan Prasar's books. It appears that there is lot of scope for promoting Vigyan Prasar's books in SAARC countries.

### Popular Science Writing in 19th Century Bengal

As part of its effort to document popular science writings in different Indian languages, Vigyan Prasar had commissioned a project to Science Communicator's Forum, Kolkata for popular science writings in Bengali. Earlier, a similar project for Hindi was completed by Vigyan Parishad Prayag. The period covered in Bengali was 1818 to 1860. The final project report in the form of compilation of selected articles/writings and with a detailed introduction was handed over to Vigyan Prasar by Professor Sushil K. Mukherjee, former Vice Chancellor of Calcutta University, Jadavpur University and Kalyani University, at Kolkata on August 24, 2002. The function was held at Loreto Day School, Sealdah, Kolkata.



*Prof. S.K. Mukherjee handing over the manuscript to Dr. S. Mahanti of Vigyan Prasar on Aug. 24, 2002 at Kolkata. Also seen Dr. Amit Chakrabarty and Prof. S.S. Ray (Sitting)*

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- Interview With Prof. Asis Datta 

**...think scientifically, act scientifically ... think scientifically, act scientifically ... think scientifically, act...**

# Acharya Jagadis Chandra Bose

## A Pioneer of Modern Indian Science

Subodh Mahanti

"In a large forest the trees shed their dry leaves one by one in profusion thus making the soil underneath fertile. In a country where there is continuous research in science, knowledge of it in fragmentary bits is being spread constantly. This is how one's heart's soil is quickened, becoming fertile with an alive feeling in science. It is the loss of it that has left our mind unscientific. We feel the impoverishment not only in our education, but also in the field of our occupation where we are bowed with frustration."

Rabindranath Tagore in '*Bishwa-Parichaya*' quoted from its English version titled "Our Universe" translated by Indu Dutt.

"If there was been any success in my life that was built on the unshakable foundation of failure..."

Jagadis Chandra Bose

"Bose was a physicist and a physicist he remained in his outlook to the very end."

Meghanad Saha

"The generally accepted interpretation of Jagadis Chandra's scientific activities is that he had essentially the biologist's conception of Nature; lack of opportunities for biological studies while as a student in Calcutta and later lack of any teaching post in biology, induced Jagadis Chandra to take up the post of teacher in physics..."

D.M. Bose

He (Bose) was modern India's first physicist after all, one of her very first scientists. He was his motherland's first active participant in the Galilean - Newtonian tradition. He had confounded the British disbeliever. He had shown that the Eastern mind was indeed capable of the exact and exacting thinking demanded by western science. He had broken the mould.

S. Dasgupta in "*Jagadis Chandra Bose and the Indian Response to Western Science*".

Jagadis Chandra Bose, popularly known as J.C. Bose, occupies a unique position in history of modern Indian science. He is regarded as India's first modern scientist. But then it is also true that Bose was not the only pioneer of modern Indian science. Prafulla Chandra Ray (1861-1944), who established an Indian school of chemistry and a chemical industry, and Srinivasa Ramanujan (1887-1920), the great mathematician, are equally familiar names in the annals of modern history of Indian science and who were Bose's contemporaries. It was Ramanujan, who was first elected as Fellow of the Royal Society, the ultimate recognition given by the British Scientific establishment. But then as one of Bose's biographers, Subrata Dasgupta, writes : "Bose was the first Indian to be admitted in person to the *sanctum sanctorum* of English, thus western science". In January 1897 Bose delivered a lecture at

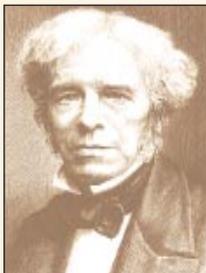


J.C. Bose

the Royal Institution, London, a Friday Evening Discourse, then most prestigious and visible platform for announcing new discoveries. It was Michael Faraday (1791-1867) who started the Friday Evening Discourse in 1826. Some of the most prominent British scientists worked in the Royal Institution and participated in these discourses. In this lecture Bose demonstrated his devices for the generation and detection of radio waves.

Bose did pioneering research, first in physics and then in physiology. In 1888 Heinrich Rudolf Hertz (1857-94) produced and detected electromagnetic waves in the 60 cm wavelength range and in doing so he verified James Clerk Maxwell's (1831-79) electromagnetic theory. However, Bose was the first to produce millimeter-length radio waves and study their properties. Bose also perfected the method of

transmission and of reception of electromagnetic waves. In recent years there has been welcome news of proper credit being given to Bose for his pioneering work in the area of wireless telegraphy. The Institute of Electrical and Electronics Engineers (IEEE) in one of their publications wrote : “ Our investigative research into the origin and first major use of solid state diode detector devices led to the discovery that the first transatlantic wireless signal in Marconi’s world-famous experiment was received by Marconi using the iron-mercury-iron-coherer with a telephone detector invented by Sir J.C. Bose in 1898.” Bose was a pioneer in microwave optics technology. He was the first to show that semiconductor rectifiers could detect radio waves. Bose’s galena receiver was amongst the earliest examples of a lead sulphide photo conducting device.



Michael Faraday

Bose’s his theories about the relationship between living and non-living and plant’s response to stimuli were not taken seriously in his time and even today some of his ideas have remained esoteric. However, as D.M. Bose, who succeeded Bose as Director of the Bose Institute, has pointed out “his model of an electric eye which records with electric signals message received from outside world, his physical model of memory as a mechanism for storing information justified his being considered a precursor of the modern discipline of cybernetics.” It is now recognised that Bose had made very significant contributions to the field of chronobiology and circadian rhythms even before these two technical terms were coined.

Bose was the pioneer of experimental science in India. He was an inventor of the first order. He devised many sensitive instruments for his research both in physics and physiology.

Bose was a close friend of Rabindranath Tagore (1861-1941) and received much emotional support from him at difficult times. Before seriously taking up scientific investigation (1894), Bose spent many of his vacations visiting and photographing historic places of scenic beauty, armed with a full sized camera. Some of his experiences he wrote down in vivid Bengali prose. These, together with some of his other literary addresses and writings, were published in a volume called ‘Abyakta’.

Jagadis Chandra Bose was born in Mymensingh, in his mother’s parental house, now in Bangladesh on 30<sup>th</sup> November 1858, the same year in which India, which was being administered by the East India Company since 1757,

came directly under crown rule. Lord Canning, Governor General, as the East India Company’s Chief Administrator of India used to be called since 1772 when Warren Hastings assumed the office, was proclaimed Viceroy. Bose’s ancestral home was at the village named Rarikhal in Vikrampur, not far from Dhaka (then Dacca), the capital of present-day Bangladesh. His father Bhagaban (also spelt as Bhagwan) Chandra Bose served the British India Government in various executive and magisterial positions. At the time when Bose was born, Bhagaban Chandra was Deputy Magistrate of Faridpur and it is here Bose’s early

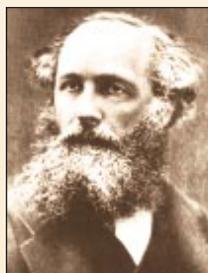
childhood was mainly spent. Bhagaban Chandra was no ordinary government servant. To quote Patrick Geddes, who was Professor of Botany at St. Andrews University, and the author of one of the most authentic biographies of Bose : “Bose’s father – Bhagaban Chunder Bose, Deputy Magistrate of Faridpur – was the active defender, not only of the townlet but of the scores of villages around as well. The modern magistrate is mainly settled between his courthouse and his home; but here in those days a man was needed, picked not only for judicial capacity, intelligence and local knowledge, but for active initiative and courage and thus prepared at any moment to assume command of his own police and his people as well, and be ready even to raid the raiders. Of this readiness various stories might be told. As a single example, hearing of a gang of

dacoits in his neighbourhood, Mr. Bose mounted an elephant and with the very few police available, rode straight into the very heart of the dacoits’ camp. Taken by surprise, they broke and scattered; the ready magistrate dropped down, captured the leader with his own hands, and took him back for trial.” Bhagaban Chandra had kept in his household a dreaded ex-dacoit, whom he had earlier sentenced to

imprisonment, to look after young Jagadis Chandra. Though Bhagwan Chandra served the British Government he was a staunch nationalist and also a dreamer. He undertook, not always with success, many educational, agricultural and technical projects aiming to provide employment and promote opportunities to his less fortunate countrymen. In 1869 Bose’s father went to Burdwan as Assistant Commissioner. Here he opened workshops in carpentry, in metal turning in general metalwork and even a foundry. Bose was very much influenced by his father’s ideals. While speaking at the fiftieth anniversary of the Exhibition and Mela founded by his father at Faridpur Bose said : “A failure ! Yes, but not ignoble nor altogether futile. And through



Heinrich Rudolf Hertz



James Clerk Maxwell



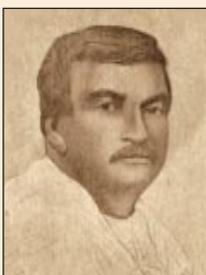
The Bose Institute

witnessing this struggle, the son learned to look on success or failure as one, and to realize that some defeat may be greater than victory. To me his life has been one of blessing, and daily thanksgiving. Nevertheless everyone had said that he had wrecked his life, which was meant for greater things. Few realize that out of the skeletons of myriad lives have been built vast continents. And it is on the wreck of a life like his, and of many such lives, that will be built the the greater India yet to be. We do not know why it should be so; but we do know that the Earth-Mother is always calling for sacrifice.”



Rabindranath  
Tagore

Bose started his education in a vernacular or Bengali School, a *pathsala*, which was founded by his father in Faridpur. It may be noted that Bhagaban Chandra could have easily sent his son to the local English School. However, he wanted his son to learn his mother tongue and know his own culture before he learned English and knew the foreign culture. In this *Pathasala* Bose studied with the children of peasants, fishermen and workers. In their company Bose imbibed a love of nature. Bose often attended *Jatras* (folk plays) in village fairs and which inspired him to read the great epics, *Mahabharata* and *Ramayana*. The character of Karna in *Mahabharata* influenced him deeply. To quote Bose: “From his (Karna’s) low caste came rejection, came every disadvantage; but he always played and fought fair! So his life, though a series of disappointments and defeats to the very end – his slaying by Arjuna—

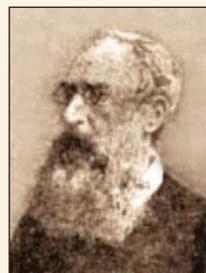


Bhagaban Chandra  
Bose, J.C. Bose's  
Father

appealed to me as a boy as the greatest of triumphs. I still think of the tournament where Arjuna had been victor, and then of Karna coming as a stranger to challenge him. Questioned of name and birth, he replies, “I am my own ancestor! You do not ask the might Ganges from which of its many springs it comes: its own flow justifies itself, so shall my deeds me!” Further he wrote : “Like that of my boyhood’s hero Karna, my life has been ever one of combat and must be to the last. It is not for man to complain of circumstances, but bravely to accept, to confront, and to dominate them.”

In 1869 Bose was sent to Kolkata (then Calcutta), where after spending three months at the Hare School he was admitted in St. Xavier’s College, which was both a secondary school and a college. This institute was founded by Belgian Jesuits in 1860. Here Bose came in contact with Father Eugene Lafont (1837-1908), who played an important role in developing a tradition of modern science in Kolkata. With Lafont’s initiative St. Xavier’s College put a special emphasis on science teaching. In 1875 he established a small astronomical observatory in the College. He was one of those principals who persuaded the Calcutta University to offer an undergraduate course in science.

Lafont also gave popular science lectures at the Indian Association for the Cultivation of Science, which was established by Mahendra Lal Sircar (1833-1904) in 1876.



Father Eugene  
Lafont

In fact, he was the first lecturer of the Association. Bose was very much influenced by Lafont. To quote Patrick Geddes: “All the pupils of Father Lafont, so long Professor of Physics in that College (St. Xavier’s College), recall his teaching and influence as truly educative. His wealth of experiments and vivid clearness of exposition of them, made is class most interesting in the hole college; and his patient skill, his subtlety, as well as brilliance of

experimentation, were appreciated by this young student above all. Here was Bose’s first discipline towards that combination of intellectual lucidity with wealth of experimental devise and recourse by which he has all the more fully represented and honoured his old master by surpassing him.”

In 1879 Bose passed the BA examination in Physical Science Group of the Clacutta University. At the time of his graduation Bose did not have clear plan for his future career

except that he wanted to go to England for higher training. However, his father’s economic situation was far from satisfactory for this venture. His father’s innovative schemes and investment had mostly failed and as a result he was burdened with debts. There were some projects which were successful but then Bose’s father did not make profit out of them. For example the People’s Bank, the forerunner of the later co-operative societies, started by his father was highly successful. Had Bose’s father

kept the shares that he had bought as its founder there would have been no financial difficulty. But he had given away his shares to his poorer friends. Bose decided that his first duty was to earn money and help his father in paying off the debts. Following his father’s example the natural choice was to join the coveted Indian Civil Service. However, his father did not want his son to become a civil servant, which he thought would take his son away from the common people. In fact, his father wanted that his son should be helpful to the common man and which could not be done by becoming a civil servant in British India. Finally it was decided that Bose would study medicine in some English University. In realizing this goal Bose faced two difficulties. First as stated above his father’s financial condition was totally inadequate to support such expensive educational stay in England. What is more at that time Bhagaban Chandra was on two years’ medical leave on reduced pay and he was not sure when his health would permit him to resume his duties with its full pay. His second difficulty was his mother’s worry in sending him to unknown western world. In those days the sea-voyage was considered



Banasundari  
Devi, J.C. Bose's  
Mother

extremely dangerous. And she had lost her second son, aged ten and so she had become highly possessive of her only remaining son. But when considering these factors Bose had decided to settle down in India, and see what he could do best, his mother Banasundari Davi, suddenly decided that his son should go to England as he had originally planned. She said: "My son, I cannot understand much of this going to Europe, but I see your heart's desire is to educate yourself to the utmost; and so I have made up my mind. You shall have your heart's desire. Though nothing is left of your father's fortune, I have my jewels; I have even some money of my own. Between these I can manage it. Go you shall". For a mother it was a courageous decision and India and Indians should be thankful to her. After his mother's consent his father also readily agreed. His objection was to becoming a civil servant and studying law. So selling her mother's jewels Bose sailed for England.

However, after a year's study he had to abandon his plan to study medicine because of the recurrence of a fever he had contracted earlier, and which exacerbated, by the odours of the dissecting rooms. In January 1882 Bose left London for Cambridge where he took admission in Christ's College to study natural sciences. His decision to join the Christ's College was influenced by the fact that his brother-in-law, Ananda Mohan Bose (1847-1906), had earlier studied there. Ananda Mohan, who took the Mathematics Tripos in 1874, was Cambridge's first Indian wrangler.

Among Bose's teachers at Cambridge were: Lord Rayleigh (1842-1919), Michael Foster (1836-1907), Sidney Vines (1849-1934) and Francis Darwin (1848-1925).

In 1884 Bose obtained a Bachelor of Arts with a second class in natural sciences tripos and in the same year he also obtained a Bachelor of Science from the University of London. After coming back to India he joined the Presidency College at Kolkata in 1885. He was the first Indian to be appointed Professor of Physics in the Presidency College. His appointment was strongly opposed by Sir Alfred Croft, then Director of Public Instruction of Bengal and Mr. Charles R. Tawney, Principal of the Presidency College. But Bose finally managed to get the appointment because of the intervention of Lord Ripon, then Viceroy of India. In getting his appointment Bose was helped by Professor Fawcett, the economist and then Postmaster-General of Britain. Fawcett was a friend of Bose's brother-in-law Ananda Mohan Bose. With Fawcett's letter of introduction Bose met Lord Ripon at Shimla. In those days, Shimla used to be the summer capital of India. Ripon was very nice to Bose and he

promised to nominate him for the Imperial Educational Service. But after coming to Kolkata when Bose met Croft he was not at all welcomed. Croft said : "I am usually approached from below, not from above. There is no higher-class appointment at present available in the Imperial Educational Service, I can only offer you a place in the Provincial Service, from which you may be promoted." Bose did not accept the offer. The Viceroy again wrote to the Government of Bengal asking explanation for the delay in appointing Bose. Finally Croft was forced to appoint Bose.

In those days the Britishers thought that Indians were not capable of holding high post in educational service and thus Imperial Educational Service was out of their bound, howsoever qualified might they be. For example P.C. Ray, who returned from England with a PhD degree, could not make it to the Imperial Educational Service. He had to be content with the Provincial Service. Unlike in case of Indian Civil Service, which an Indian could join by passing the prescribed examination, the Imperial Educational Service was accessible only through nomination.

Though Bose, because of Lord Ripon's personal intervention, was given an appointment in the higher service he was taken on temporary basis with one-half of the pay attached to such an appointment. Bose protested and he asked for the same salary as an European was entitled to get. When his protest was not entertained he refused to accept his salary. He continued his teaching assignment for three years without any salary. Finally both the Director of Public Instruction and the Principal of the Presidency College fully realised the value of Bose's skill in teaching and also his lofty character. As a result his appointment was made permanent with retrospective effect. He was given the full salary for the last three years in lumpsum, which he used for paying off his father's debt.

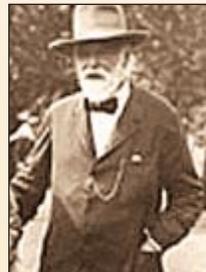
In 1894 on his thirty-fifth birthday Bose decided to pursue scientific research and not to be confined with teaching assignment alone. There was no laboratory or apparatus or peers. He conducted his researches in a small 24 square foot room, which he was given in the Presidency College. With the help of an untrained tinsmith he devised and constructed new apparatus for his first research on electric radiation. Bose was inspired to study the properties of electric waves after reading Oliver Lodge's book *Heinrich Hertz and His Successors*. Bose devised and fabricated a new type of radiator for generating radio waves. He also built a unique and highly sensitive 'Coherer' or radio receiver for receiving radio waves. Bose's coherer was far more compact, efficient



Lord Rayleigh



Michael Foster



Oliver Lodge



Two plants *Mimosa pudica* and *Desmodium gyrans* that accompanied Bose round the world

and effective than the ones used in Europe. It was Oliver Lodge who had devised an improved version of coherer invented in 1890 by Eduard Branly (1846-1940) of France. Though Branly invented the coherer but he did not conceive it as a detector, it was Lodge's contribution. Even the term 'coherer' was coined by Lodge. Branly had shown that metal fillings enclosed in glass tubes with loose contacts form an insulator. Though the fillings themselves were good conductors, they would be highly resistant to small voltages. However, in the presence of Hertzian waves their resistance was enormously reduced or in other words they switched to a conducting state and they would remain in that state until shaken or tapped slightly. In the coherer developed by Lodge wires in contact with the fillings placed in a glass tube led out from the end of the tube and were connected in a series with a galvanometer. When there is a radiation, the fillings would switch to a conducting state and a current would be obtained and which will be detected by the galvanometer. Bose's receiver was a great advance on that of Branly and Lodge. In earlier versions the sensitivity varied and at times they behaved in an erratic manner. Bose replaced the irregular fillings by fine wire spiral springs. They were fixed in ebonite and under control of a spring. Using his improved equipment Bose demonstrated various properties of radio waves like reflection, absorption, interference, double reflection and polarisation. He also demonstrated a new type of radio waves as small as 1 centimeter to 5 millimeters. Such waves are now called microwaves, and are used in radars, ground telecommunication, satellite communication, remote sensing and microwave ovens.



Lord Kelvin

In May 1895, he read his first research paper before the Asiatic Society of Bengal 'On the polarisation of Electric Rays by Double Reflecting Crystals'. In the same year one of his papers titled "On the Determination of the Indices of Refraction of Sulphur for the Electric Ray" was communicated to the Royal Society of London by Lord Rayleigh. The paper was read before the Royal Society in December 1895 and it was accepted for publication in the Society's proceedings in January 1896. Bose's three articles were published in *The Electrician* of Friday 27 December. These were probably the first papers to be published by an Indian in a western scientific periodical. It may be noted that in those days, *The Electrician* was amongst the most prominent periodicals devoted to electrical matters. In spite of the most adverse circumstances Bose succeeded just by his sheer dedication and ingenuity. The Royal Society of London not only accepted his paper for publication, also offered him financial help from their Parliamentary grant so that Bose could continue his researches. The University of London awarded him Doctor of Science (DSc) without any examination. Lord Kelvin congratulated Bose by stating that he was "literally filled with wonder and admiration...for



Marie Alfred Cornu

his success in the difficult and novel experimental problem". Marie Alfred Cornu (1841-1902), the former President of the French Academy of Sciences, wrote : "the very first results of your researches testify to your power of furthering the progress of science. For my own part, I hope to take full advantage of the perfection to which you have brought your apparatus, for the benefit of the Ecole Polytechnique and for the sake of further researches I wish to complete."

Bose's sudden success in his research and its appreciation by leading scientists in England and other western countries had their impact in India. The attention of the Lieutenant-Governor of Bengal, Sir William Mackenzie, was drawn to Bose's work and he tried to improve the conditions under which Bose was working. A new post with higher emoluments, with more initiative and with reasonable leisure for research' was created for Bose. However, this appointment was cancelled because of Bose's refusal to support the official line in a meeting of the Calcutta University, of which he was a Fellow. After failing to overcome the opposition of the Education Department in giving sanction to the new appointment the Lieutenant Governor decided to reimburse the expenditure incurred by Bose in carrying out his researches. However, Bose refused to accept the grant for his past work. But he accepted the Government's annual grant of Rs. 2500/- (£166) for his future research work at the Presidency College.

At the initiation taken by William Mackenzie, the Education Department agreed to send Bose on deputation to England for six months. And he sailed for England on 24<sup>th</sup> July 1896. He gave a lecture-cum-demonstration on his new findings on radio waves at the meeting of the British Association for Advancement of Science at Liverpool. Among those present were Sir James Johnson Thomson (1856-1940), Oliver Lodge and Lord Kelvin. It was Bose's first interaction with the English scientists after his success in research. The assembled scientists were highly impressed by Bose's presentation. Lord Kelvin climbed up to the ladies' gallery to congratulate Mrs. Abala Bose on her husband's brilliant work. He was also invited by the Royal Institution to deliver a Friday Evening Discourse. It was a great honour. The Government of India extended his deputation for another three months for the preparation of the lecture. He delivered his Friday Evening Discourse on 19<sup>th</sup> July 1897. The title of the lecture was 'On the polarization of Electric Rays". More than five hundred people including Oliver Lodge, James John Thomson and Lord Kelvin had assembled to hear Bose. The lecture was not only praised but it was considered valuable enough for publication in the Transactions of the Royal Society. Bose's fame spread quickly to the neighbouring countries, France and Germany. He was invited by Physical Society of Paris and leading physicists of Berlin to explain his results.

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Bose's peers in England were highly impressed by his achievements and they wanted to help improve the conditions under which Bose was working. He had no proper laboratory for carrying out his research work. Lord Kelvin wrote to Lord George Hamilton, then Secretary of State: "It would be conducive to the credit of India and the scientific education in Calcutta, if a well-equipped Physical Laboratory is added to the resources of the University of Calcutta in connection with the Professorship held by Dr. Bose." Lord Kelvin's letter was followed by a letter jointly signed by a number of eminent scientists including Lord Joseph Lister (1827-1912), then President of the Royal Society, Professor Fitzerland, Sir William Ramsay, Sir George Gabriel Stokes (1819-1902) and many others. This communiqué stated: "to the great importance which we attach to the establishment in the Indian Empire of a Central Laboratory for advanced teaching and research in connection with the Presidency College, Calcutta. We believe that it would be not only beneficial in respect of higher education, but also that it would largely promote the material interest of the country; and we venture to urge on you the desirability of establishing in India a Physical Laboratory worthy of that great Empire." The Secretary of State not only sent the letter to the Government of India but he also endorsed the proposal by stating that 'being of opinion that the question of establishing an institution of the kind mentioned is deserving of consideration by Your Excellency in Council.' Though the then Viceroy Lord Elgin informed Bose that the government would be interested in his project but the concerned government department finally decided that though the project was important but it might be postponed for future. The foundation of such a laboratory was laid in 1914, just one year before Bose's retirement

Bose was very much against in patenting his invention. He had resolved not to seek any personal advantage from his invention. He pursued science to only for itself but for its application to the benefit of mankind. In his Friday Evening Discourse at the Royal Institution, London, he made public his construction of the coherer. Thus *The Electric Engineer* expressed 'surprise that no secret was at any time made as to its construction, so that it has been open to all the world to adopt it for practical and possibly moneymaking purposes." In 1901, one of the great manufacturers of wireless apparatus, approached Bose for signing a remunerative agreement as to his new type of receiver. However, Bose declined the offer. One of his American friends, Sara Bull (also known as Mrs. Ole Bull), was able to persuade Bose to file a patent application for his galena receiver. The application was filed on 30 September 1901 and it was granted on 29 March

1904 (US patent No. 755,840). However, Bose refused to accept his rights and allowed to lapse the patent.

Fascinated by the peculiar behavior of his electric-wave receiver, which seemed to show signs of "fatigue" after prolonged use but could be 'revived' to its original sensitivity after some rest, Bose took up a systematic study to understand this phenomenon. He started believing that metals too had "feelings". From metals he turned his attention to plants and he found the latter responding more favorably to his experiment than the former. Bose thought that he had hit upon the underlying unity in the natural world between living and non-living. And he fully devoted to this line of investigation.

In 1900 Bose read his paper "On the Similarity Responses of Inorganic and Living Matter" before the Paris International Congress of Physicists. It was for the first time in science one compared and parallelised the responses to the excitation of living tissues with those of inorganic matter. Bose's paper was considered as one of the most important ones received by the Congress. The paper was published in the Proceedings of the Congress. Many in India thought that Bose had given a fresh scientific impetuous to the age-old wisdom of the East which believed in the basic unity of all life. Swami Vivekananda (1863-1902), who was then in Paris, went to hear Bose at the Congress. While describing his impression of the Congress Swami Vivekanand wrote : "Here in Paris have assembled the great of every land, each to proclaim the glory of his country. Savants will be acclaimed here; and its reverberation will glorify their countries. Among these peerless men gathered from all parts of the world, where is thy representative, O thou the country of my birth ? Out of this vast assembly a young man stood for thee, one of thy heroic sons; whose words here electrified the audience, and will thrill all his countrymen." Tagore sent his appreciation in the form of a poem.

At the Physical Section of the British Association's meeting at Bradford, England in September 1900 Bose read a similar paper. Here also his ideas were widely appreciated by the physicists. After the Bradford meeting Bose fell ill and he was confined for two months. On recovery, he was invited by his old friends and teachers. Lord Rayleigh and Sir James, Dewar (1842-1923) to work at the Davy-Faraday Laboratory of the Royal Institution. Bose delivered his second Friday Evening Discourse at the Royal Institution on May 10, 1901. This time on his research on the responses to living and non-living. The lecture was highly appreciated. Bose's ideas were first opposed by John Burdon Sanderson and Augustus Waller, the two eminent plant physiologists on June 6, 1901 when Bose read his paper at the Royal Society. Following their criticism the Royal Society did not



Swami Vivekananda



Abala Bose  
Bose's wife



Bose delivering his Friday Evening Discourse before the Royal Institution

publish this paper. Bose decided to prolong his stay at London to conduct experiments to prove his theory. Somehow he managed to get his deputation extended. After his two year stay Bose decided to come back India though he was offered a job at a British University.

After coming back to Kolkata Bose continued his work on the responses living and non-living and the physiological properties of plant tissues and the similarity of their behaviour with that of animal tissues. He presented the results of his investigation in the form of monographs.

Bose demonstrated that plant tissues under different kinds of stimuli like mechanical, application of heat, electric shock, chemicals and drugs, produce electric response similar to that produced by animal tissues. He also tried to demonstrate that similar electric response to stimulation could be noticed in certain inorganic systems. For his investigations Bose invented several novel and highly sensitive instruments. Among these the most important one was the Crescograph – an instrument for measuring the growth of a plant. It could record a growth as small as 1/100,000 inch per second. Bose's experiments on plants were mostly performed on *Minosa pudica* and *Desmondium gyrans* (Indian Telegraph plant). In all his investigations Bose attempted to offer original interpretations. He attempted to devise models which were illustrative of physical basis of memory. His findings subsequently influenced subjects like physiology, chronobiology, cybernetics, medicine and agriculture.

Bose retired from educational service as Senior Professor of Physics in 1915. In fact he was to retire in 1913, on the completion of his fifty-fifth year, as per Government rules of those days. However, the Government of Bengal, in recognition of his service to the Presidency College and of his scientific achievements, extended his period of service for two years. After his retirement the Government also made him Professor Emeritus on full pay instead of pension. And this way he remained permanently connected to the Presidency College. Even after his retirement his researches were not interrupted. He continued his plant physiological investigation in a small laboratory set up in his own house. In the meantime he was also working towards the establishment of a research institute. The foundation ceremony of this institute took place on 23<sup>rd</sup> November 1917. Bose was able to collect about Rs. 11 lakhs for its endowment, in this effort he was greatly helped by his friend Rabindranath Tagore. Bose became its life-

time director. His inagural speech summarising the ideals that led him to establish the institute was really inspiring. Here we quote a part of it:

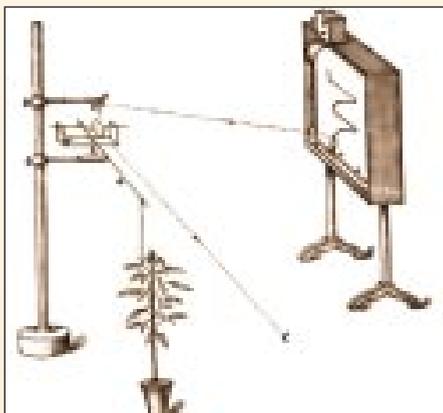
I dedicate to-day this Institute – not merely a Laboratory but a Temple... The advance of science is the principal object of this Institute and also diffusion of knowledge. We are here in the largest of all the many chambers of this House of Knowledge – its Lecture Room. In adding this feature, and on a scale hitherto unusual in a Research Institute, I have sought permanently to associate the advancement of knowledge with the widest possible civic and public diffusion of it; and this without any academic limitations, henceforth to all races and languages, to both men and women alike, and for all time coming.

The lectures given here will not be mere repetitions of second-hand knowledge. They will announce, to an audience of some fifteen hundred people, the discoveries made here, which will be demonstrated for the first time before the public. We shall thus maintain continuously the highest aim of a great seat of learning by taking active part in the advancement and diffusion of knowledge. Through the regular publication of the *Transactions of the Institute*, these Indian contributions will reach the whole world. **The discoveries made will thus become public property.** Besides the regular staff there will be selected number of scholars, who by their work have shown special aptitude, and who would devote their whole life to the pursuit of research. They will require personal training and their number must necessarily be limited. But it is not the quantity but quality that is of essential importance.

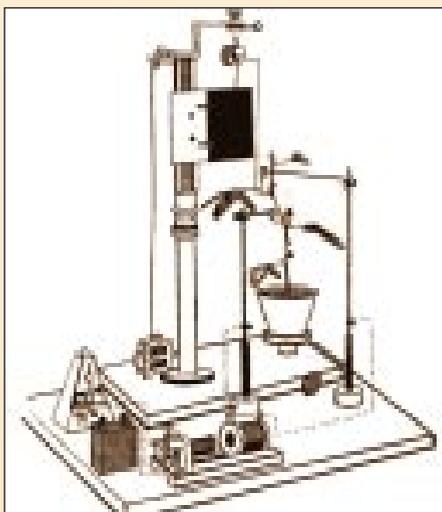
It is my further wish that, as far as the limited accommodation would permit, the facilities of this Institute should be available to workers from all countries. In this I am attempting to carry out the tradition of my country, which, so far back as twenty-five centuries ago welcomed all scholars from different parts of the world within the precincts of its ancient seats of learning at Nalanda and at Taxila...

Not in matter but in thought, not in possessions nor even in attainments but in ideals, is to be found the seed of immortality. Not through material acquisition but in generous diffusion of ideas and ideals can the true empire of humanity be established. Thus to Asoka, to whom belonged this vast empire, bound by the inviolate seas, after he had tried to

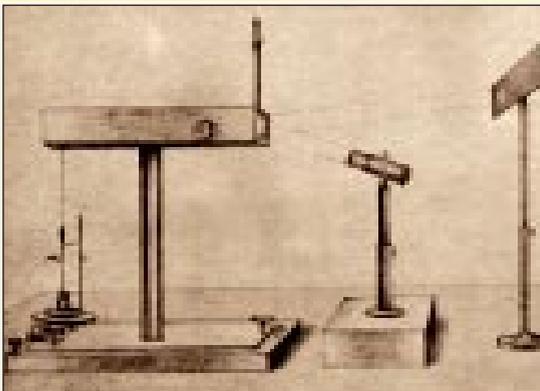
ransom the world by giving away to the utmost, there came a time when he had nothing more to give, except one half of an Amlaki fruit. This was his last possession, and his



The Optical Pulse-Recorder



General view of the Resonant Recorder



*The Magnetic Crescograph for magnifying imperceptible growth of plants ten million times*

anguished cry was that since he had nothing more to give, let the half of the *Amlaki* be accepted as his final gift.

Asoka's emblem of the *Amlaki* will be seen on the cornices of the Institute, and towering above all is the symbol of thunderbolt. It was the Rishi Dadhichi, the pure and blameless, who offered his life that the divine weapon, the thunderbolt, might be fashioned out of his bones to smite evil and exalt righteousness. It is but half of the *Amlaki* that we can offer now. But the past shall be reborn in a yet nobler future. We stand here today and resume work tomorrow, so that by the efforts of our lives and our unshaken faith in the future we may all help to build the greater India yet to be."

Bose's inaugural speech produced a profound impression both in India and abroad. One of London's leading newspapers, *The Times* wrote : "To bringing about the scientific renaissance (In India) Sir Jagadis had influentially contributed. Indians are justly proud of the possession of a few men who have gained world-wide reputation in their particular fields of activity, and this pride reacts strongly on public opinion. At the Research Institute a group Indian post-graduate students devote their lives to research. The published Transactions of the Institute show that under the leadership of this eminent Bengali, Indian research is making substantial contribution to scientific knowledge, that in this field there is no fundamental difference between the Western and the Eastern mind, as was assumed when Sir Jagadis began his work". *The Athenaeum* wrote : "The foundation of an Institute for research in pure science is an event in the history of India. The publication of the Transactions, the first fruits of its activity, shows that it is an event also in the history of science."

In 1903 Bose was honoured with Commander of the Order of the Indian Empire (CIE) at Delhi by the British Government. He received in 1912 the Commander of the Star of India (CSI) at the Coronation of the British Emperor. He was knighted by the British Government in 1916. Bose was elected a fellow of the Royal Society (FRS) of London in 1928. Bose died on 23 November 1937 at Giridih in Bihar.

We would like to end this article by quoting Geddes : "The life-story of Jagadis Bose is worthy of close and ardent consideration by all young Indians whose purpose is shaping

itself towards the service of science or other high cause of the intelligence or social spirit. It is possible that looking upon the triumph of the end and knowing nothing of the long uphill road, the slow costly attainment of ends, they may think that a fine laboratory or other material endowment the antecedent condition of successful achievement in intellectual creation. The truth indeed, is far otherwise. The countless obstacles which had to be surmounted only called forth in Bose all the endurance and all the effort which are latent in manly natures, welding them to the fullest strength of character and intensity of thought by which alone a great life-task can be accomplished. In contemplating the great career of his fellow countrymen, the young India will be stimulated to put brain and hand to fine tasks, nothing fearing. Thus will he be inspired not only to recover the noble intellectual tradition of the Indian past, but to restate these traditions in modern times and find the greatest challenge for mind and soul in achieving their vital relation with the coming age."

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