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Monthly Newsletter of Vigyan Prasar

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VP News

Inside

Hello Stars

Vigyan Prasar released its latest book entitled "Hello Stars". It is about night sky watching. The book release ceremony was held on 10 October 2001 in the Raman Auditorium of Technology Bhawan, DST, New Delhi. The audience comprised of scientists of DST, authors of Vigyan Prasar publications, school teachers, students and some enthusiastic sky-gazers. Amongst the dignitaries present on the dias were Prof. V.S. Ramamurthy, Secretary, DST; Prof. Rajesh Kochhar, Director, NISTADS, who presided over the function; Mr. Anuj Sinha (Head, NCSTC), Dr. V. B. Kamble (Acting Director, VP) and the author, Mrs. Usha Srinivasan.

Dr. V. B. Kamble in his welcome address gave an account of the activities of Vigyan Prasar with emphasis on publications. Mr. Anuj Sinha highlighted the need to publish books that would generate wider interest in the youth of the country. The book was released by Prof. V.S. Ramamurthy. Speaking on the occasion, Prof. Ramamurthy emphasized that the best laboratory one can ever work in is out in the open. Nature is the best educator. Prof. Kochhar delivered the presidential address. He said that children with their curiosity are perhaps the best scientists.

The author was introduced by Mr. Arup Kumar Misra and the function was compered by Dr. Subodh Mahanti, who also gave a vote of thanks.

Mrs. Usha Srinivasan's introduction of the book was full of her interesting experiences that led to her decision to compile them in a book form, thus "Hello Stars".

The book "Hello Stars" aims at enthusing the students by making the subject of night sky watching interesting. The language is simple and lucid. The book informs the readers about scientific facts of astronomy along with providing interesting insight into myths and popular beliefs about stars and constellations. "Hello Stars" contains seven chapters: 'The Night Sky'; 'The Zodiacal Constellations'; 'Let us make Friends with Stars'; 'Stars, Constellation and Festivals'; 'Astronomy in India'; and Hello Stars, How are you?

To make the reader comprehend the various aspects of astronomy provided in the book more clearly, some simple models and projects are given towards the end. The book has been the result of a project on popularisation of astronomy.

At the book release function of "Hello Stars", Prof. Ramamurthy presents a copy of the book to the author Ms. Usha Srinivasan. Also seen in picture are Dr. V. B. Kamble, Director, Vigyan Prasar and Prof. Rajesh Kochhar, Director, NISTADS (extreme right)

A section of the audience at the book release ceremony

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

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Editor : Dr. V.B. Kamble

No Longer Hypothetical

Not even a month had elapsed since the deadly attacks on the World Trade Centre twin towers in which thousands perished, when the fear of yet another attack gripped the U.S. But, this time it was a different story altogether. It was the human exposure to the dreaded anthrax bacteria that escalated the long-felt fears of the possible deployment and use of biological weapons in warfare. Now it seems that this fear is no longer hypothetical.

Till a few years ago, talks on chemical or biological terrorism began this way: "*if* a chemical or biological attack *were* to take place ....." ! The attack on the Tokyo subway system in 1995 in which the nerve gas sarin was unleashed by the Aum Shinrikyo cult, preceded by the one in 1994 against the city of Matsumoto, changed all that. If a chemical attack is frightening, a biological weapon poses a worse nightmare. The small quantity of anthrax needed for a lethal inhalation dose can be easily concealed, transported and disseminated. Odourless and invisible, it makes a very stealthy killer. In theory, a kilogram can eradicate hundreds of thousands of individuals living in a metropolitan area, but for the inactivation or degradation when released in the environment. Further, anthrax spores can be stored for decades without losing their viability. Unlike chemical agents which are inanimate, bacteria and viruses may be contagious and reproductive. If they become established in the environment, they may multiply and unlike any other weapon, may become more dangerous over time.

Certain biological agents incapacitate, whereas others kill. Biological weapons can range in lethality from salmonella used to temporarily incapacitate to super bubonic plague engineered for mass casualties. Biological agents may be used to kill or disable humans or to attack plants or animals to harm a nation's economy. The Ebola virus, for example, kills as many as ninety per cent of its victims in about a week. For Ebola, there is no cure, no treatment. Biological weapons may include even toxins which are deadly substances originally produced by living organisms.

What is alarming is the fact that production of biological or chemical warfare agents is certainly within the reach of a dedicated and skilled group, and it does not require the resources or the technical assistance of the State. Much or all of the necessary production equipment and technology is available in the open market. Many deadly agents, including anthrax and plague can be found in nature. Given an initial biological culture, anyone who can brew beer can probably grow biological warfare agents. Even so, the entire process of producing and disseminating chemical or biological agents is not so trivial, and may require certain degree of knowledge and skill. Making biological weapons requires sample cultures; the means to grow, purify, and stabilize them; and the means to reliably disseminate them. In fact, it is said that in some countries, efforts are already on to build arsenals of biological weapons. Further, advances in genetic engineering and molecular biology could make it possible to develop a "super-pathogen" in a laboratory resistant to any known drugs or antibiotics.

Given that there are at least some people or groups in the world who would actually use these agents against civilians, what could be done? True, this is hitherto an unknown dimension of warfare. To effectively counter the terror of these germs of war, it would be necessary to exchange information and resources in a coordinated manner. When a biological attack takes place, what is required is the information on the source of the agent causing these attacks on the individuals, charting out of preventive measures, and a high level of preparedness to face up to the challenge posed by the micro-organisms released. It is equally important to initiate coordinated international efforts to curb the possibility of terrorist groups either developing or gaining control over chemical or biological weapons.

Most important, it would be imperative to improve the public health infrastructure in the country. Bhopal gas tragedy; and dengue and plague epidemics that broke out a few years ago in our country (hope they were not acts of bio-terrorism!); provided a glimpse of what a chemical or a biological warfare could be like. Remember to what extent the public and private health systems got stretched? Remember the fear and panic caused on all these occasions? In order that we are not caught unprepared, we need to begin drawing up contingency plans and formulate a comprehensive public health policy to counter such attacks. This may include replenishing expired stocks of vaccines and drugs (they have a limited shelf-life!), antidotes, replacing obsolete or expired equipment and so on. In addition, it would be necessary to pursue development of equipment to detect and identify the chemical or biological agents, to protect individuals from exposure, to decontaminate affected people, equipment and locations, and to provide medical treatment to the victims. We can perhaps never eliminate the possibility of chemical or biological terrorist attacks, but these activities will make us better equipped to respond to one, should it ever occur.

There is no gainsaying the fact that the vigil and the public confidence are of paramount importance in countering any chemical or biological attacks. This is possible only through a massive information campaign using all the media at our disposal, and through public lectures / demonstrations encompassing aspects like basic information on agents used in chemical and biological warfare, preventive measures, and responding to the attack should the prevention fail. For science communicators, this is both a challenge and responsibility. Let us get on with it. The threat is real.

❑ *V.B. Kamble*

Editor : V.B. Kamble

The team : Vigyan Prasar Staff

Vigyan Prasar

Address for correspondence : *C-24, Qutab Institutional Area, New Delhi-110 016*
Tel. : 6967532; Fax : 6965986
e-mail : vigyan@hub.nic.in
website : http://www.vigyanprasar.com

Riding on Radio Waves
Part I

❑ V.B. Kamble

What is Radio Communication?

To the scientist radio communication is "the transmission of intelligence through space by means of electromagnetic waves". In less scholastic language it includes all the practical uses of radio waves: the transmission of news pictures by radiophoto, the guidance of friendly ships at sea and planes in the air, and the locating of hostile ones before they are seen, transoceanic links between the telephone systems of different continents and islands, the control of police cars on the roads, and of tanks and missiles in the battle areas, television services, communication using near-earth and geosynchronous satellites, communication with spacecrafts, sending commands to space probes and receiving data from them, the personal radio stations of thousands of radio amateurs – or hams as they are called, and finally the best publicised forms of radio-communication – the broadcasting services using radio and television.

On December 13, 2001, it would be 100 years since Guglielmo Marconi (1874-1937) received three dots denoting the letter 'S' in Morse code across the Atlantic from Poldhu in England to St. John's in New Foundland using radio waves. This event marked a revolution in the field of communication. Earlier, long wires, or conductors, were required to carry messages on Morse telegraphs. Not only did the "wireless" communication dispense with the need to use long conductors for communication, but it also brought the entire world much closer. Marconi was not the "inventor" of radio. Radio was a result of individual efforts of several scientists and inventors throughout the world, who were inspired by the demonstration of physical existence of radio waves by Heinrich Hertz (1857-1894). Our own Sir Jagadis Chandra Bose (1858-1937) contributed significantly in the development of the detection methods of radio waves. It is even said that a somewhat modified version of a device to detect radio waves developed by Bose was used by Marconi in his transatlantic communication (but Marconi did not acknowledge the same!). It is certainly sad that the pioneering efforts of an Indian scientist, who was truly a maker of the modern Indian Science, went unnoticed or ignored. It must, however, be borne in mind that Bose himself never claimed to be the inventor of radio. In any case, after nearly a 100 years, it is difficult to imagine a world without communication on radio waves -- be it from a radio station, TV, telephone, cellular phone, or from a ship or an aircraft -- it has become a part of our lives today. Indeed, it is a saga of over a century in which hundreds of scientists and engineers dedicated their lives. Development of radio and the discovery of the ionosphere with its reflecting layers, which act as mirrors for radio waves, is yet another leaf from the golden decade (1895-1905). We shall briefly trace the history of the birth of radio communication in this article.

Michael Faraday

The Early Experiments

Early in the 19th century, Michael Faraday (1791-1867), the famous English physicist, demonstrated that an electric current can produce a local magnetic field and that the energy in this field will return to the circuit when the current is stopped or changed. James Clerk Maxwell (1831-1879), professor of experimental physics at Cambridge, in 1864 proved mathematically that any electrical disturbance could produce an effect at a considerable distance from the point at which it occurred and predicted that electromagnetic energy could travel outward from a source as waves moving at the speed of light. However, at the time of Maxwell's prediction there were no known means of propagating or detecting the presence of electromagnetic waves in space. It was not until about 1888 that Maxwell's theory was tested by Heinrich Rudolph Hertz (1857-1894) who demonstrated that Maxwell's predictions were true at least over short distances by installing a spark gap (two conductors separated by a short gap) at the centre of a parabolic metal mirror. A wire ring connected to another spark gap was placed about five feet (1.5 metres) away at the focus of another parabolic collector in line with the first. A spark jumping across the first gap caused a smaller spark to jump across the gap in the ring five feet (1.5 metres) away.

James Clerk Maxwell

Hertz devised equipment with which he generated electromagnetic waves much longer than those of light. Since these waves, unlike light, cannot be seen, other means of discovering the presence and the paths of the waves were needed. Hertz devised these also and was able to reflect, focus, refract and even polarize the new type of waves. To understand how Hertz did all this, let us examine his equipment as shown in the sketch, Fig. 1. A spark coil equipped with a vibrating contact breaker so as to make a steady stream of sparks, was connected to the two brass rods of the transmitter. The receiver was no more than a loop of wire broken at one point by a minute adjustable air gap. Hertz found that whenever the spark coil was in operation, with sparks streaming between the two rods, it was possible to produce small sparks in the receiving loop by bringing it into the room or a nearby room and turning it into the right position as shown in Fig. 1(a). Figure 1(b) shows a top end view of the transmitter without reflector and several portions of the receiving loop (turned "edge on" to the sender) giving sparks in its gap.

Heinrich Hertz

Somewhat the same effect was also found possible when the "receiver" consisted of two rods like those of the transmitter. Hertz was able to duplicate almost all of the phenomena possible with light waves. He could reflect the waves with a flat sheet-metal mirror, focus them with a curved mirror of the same sort, refract them with prisms of insulating material and polarize them with gratings of parallel wires (Fig. 1(c)). By changing the length of his sending rods, or by equipping their outer ends with large brass balls he was able to change the "wave length". With these experiments, Hertz in fact, not only laid a broad foundation for radio communication, but was planning to do field work towards radio telegraphy over a distance when he unfortunately died at an early age.

Detecting the Radio waves

Experiments of Hertz and the existence of radio waves - also called "electric rays" or "electric waves" then - inspired a number of scientists throughout the world to investigate the properties of these and put them to practical use. One difficulty, however, was that of detecting these waves efficiently. In 1890 a French physicist, Edouard Branly (1844-1940), showed that loose iron filings in a glass tube coalesce, or "cohere", under the influence of radiated electric waves. To this basic design, Sir Oliver Joseph Lodge (1851-1940) added a "trembler", a device that shoots the filings loose between the waves. Incidentally, Lodge became assistant professor of applied mathematics at University College, London, in 1879 and was appointed to the Chair of Physics at University College, Liverpool, in 1881. During his tenure in Liverpool, he conducted experiments in the propagation and reception of electromagnetic waves. When Lodge connected the improved coherer to a receiving circuit, it detected Morse code signals transmitted by radio waves and enabled them to be transcribed on paper by an inker.

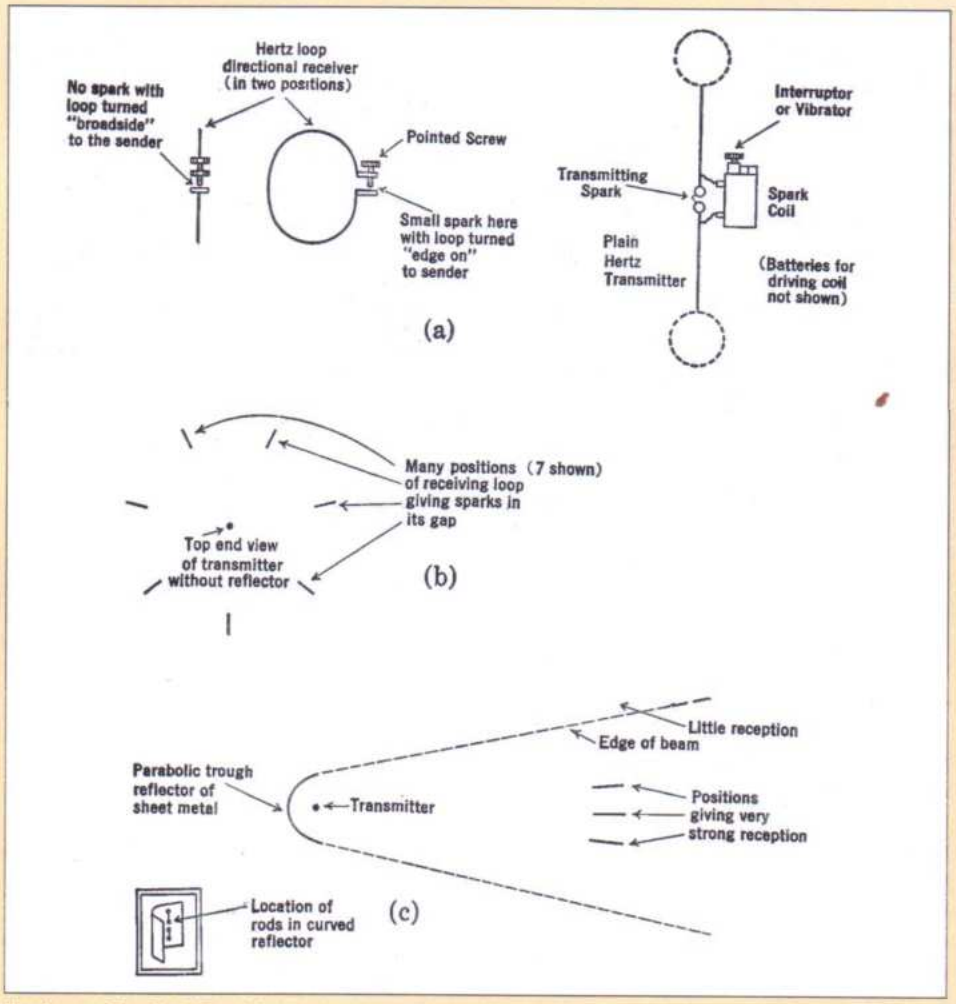


Fig. 1 : The Early Experiments

Fig. 1(a) : The first radio transmitter and receiver of Hertz.

Fig. 1(b) : A top end view of the transmitter without reflector and several portions of the receiving loop (turned "edge on" to the sender) giving sparks in its gap.

Fig. 1(c) : The beam transmitter of Hertz made out of a parabolic trough reflector of sheet metal.

Lodge's device, first demonstrated in his lecture before the Royal Institute on June 1,1894, quickly became the standard detector in early wireless telegraph receivers. The lecture was published and subsequently incorporated in a book. It had a widespread influence on the development of radio telegraphy; inspiring experimenters in Germany, Italy, Russia, and other countries including India, about which we shall discuss later. With an associate, Alexander Muirhead, Lodge formed a syndicate to exploit one of his ideas, the resonant antenna circuit, that enabled several stations to operate on different wavelengths without interference. Being a landmark in the history of radio communication, we shall briefly discuss it here.

If ten people in the same room are talking loudly, it is very difficult to understand any of them, and quite impossible to hear one of them without hearing the others. In radio we are much better off. Even Hertz' early equipment showed the possibility of adjusting the receiving device in order to favour a particular transmitter. He did it by changing the size of a receiving loop or the length of receiving rods or the size of the balls at the far end of receiving rods, a process we now call "tuning". Somehow the significance of this was overlooked for

Branly's Caherer

many years. Sir Oliver Lodge re-invented tuning, but, his methods were superior, for he did not tune the antenna itself but a separate adjustable coil and condenser arrangement connected to the antenna as shown in Fig. 2. This gave "sharper" tuning than the Hertz' method and tended to sift the desired signal from among many signals. Over the years, his device was replaced by systems such as those of the present household receivers in which the turning of a single knob adjusts not one but several such "tuned circuits" to respond most strongly to the frequency of the "wanted" station.

We may slightly digress here to state that in 1900, Marconi filed his now famous patent No. 7777 for improvements in apparatus for Wireless Telegraphy. In 1943 the U.S. Supreme Court overturned patent no. 7777, indicating that Lodge, Nikola Tesla, and John Stone Stone (John's both the parents had their family name 'Stone', hence two 'Stones' in his name!) appeared to have priority in the development of radio tuning apparatus.

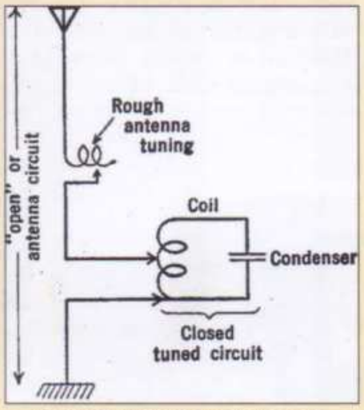
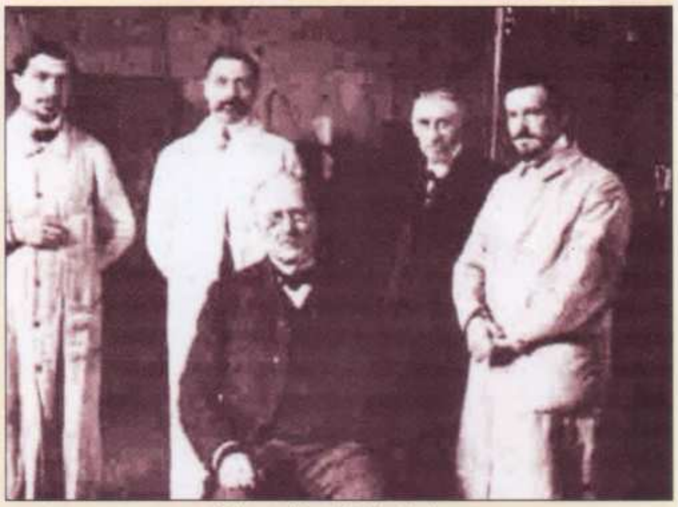


Figure 2 : Lodge's improvement

If Hertz opened the gates to the arena of Experimental Radio Physics, it was Lodge who brought in many players. We shall consider only some of them (Incidentally, Orrin E. Dunlap Jr., published a book entitled "Radio's one hundred men of science" in 1944 itself, now the number must have swelled much more !). They are: Sir Jagadis Chandra Bose (1858 – 1937) from India, Guglielmo Marconi (1874 – 1937) from Italy, Alexander Stepanovich Popov (1859 – 1905) from Russia, Nikola Tesla (1856 – 1943) from Serbia who migrated to the United States, Carl Ferdinand Braun (1850 – 1918) from Germany, Lee de Forest (1873 – 1961), John Stone Stone (1869 – 1943), and John Ambrose Fleming (1849 – 1945) from the United States. Let us briefly outline their contributions that made radio communication - or "wireless" communication as it was called - a reality.

The forgotten scientist

Jagadis Chandra Bose (30 November 1858 – 23 November 1937) was born at Mymensingh, Bengal (now Bangladesh). The son of a deputy magistrate, Bose studied at St. Xavier's, a Jesuit college in Calcutta, and then went to London to study medicine. He transferred to Cambridge University after receiving a scholarship to Christ's College and graduated in natural science in 1884. He was immediately appointed to the professorship of physics of the Presidency College, Calcutta,



Edouard Branly (Centre)

where he remained until his retirement in 1915. Bose's research career started a few years after he joined the Presidency College. He was strongly influenced by the work of Heinrich Hertz, as noted earlier. But, the greatest inspiration to study electromagnetic waves came from an article 'Heinrich Hertz and His Successors' by Sir Oliver Lodge, published in 1894. Soon, using local technicians, Bose designed and built his own equipment to start his innovative experiments. He presented his first paper on his researches, "On Polarisation of Electric Rays by Double Refracting Crystals" at the Asiatic Society in Calcutta on 1 May 1895. In the same year, he gave the first demonstration of wireless communication. In Calcutta Town Hall, in the presence of the Lt. Governor of Bengal, he transmitted electromagnetic waves from the lecture hall through intervening walls - covering a total distance of 25 metres tripping a relay which threw a heavy iron ball, fired off a pistol and blew a small mine. This was reported in some Indian news papers and also mentioned by the President of

Sir Oliver and Lady Lodge

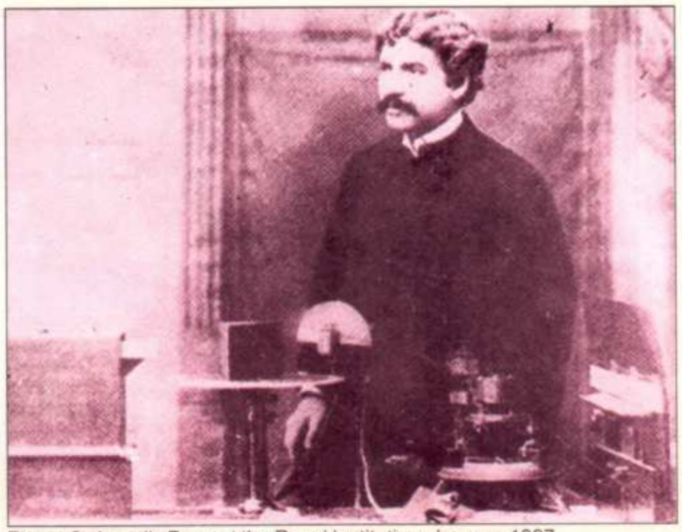


Figure 3: Jagadis Bose at the Royal Institution, January 1897
Source: Jagadis Chandra Bose and Indian Response to western science by Subrata Dasgupta. Original source: Bose Institute.

Asiatic Society in his address in 1895. Incidentally, to get this result from his small transmitter, Bose had set up an apparatus which anticipated the lofty antennae used by Marconi and also used in later day wireless telegraphy.

However, Bose's most significant contribution was in devising a sensitive detector used to receive radio waves. In the early days of wireless experiments, before amplifiers came into use, it was the sensitivity of the detector on which depended success or failure. The trouble with the kind of coherer used at that time was that it required shaking or tapping almost each time after exposure to radio waves for restoring its sensitivity. To avoid this problem, Bose devised a novel coherer using a series of tiny spiral springs that didn't need tapping to restore sensitivity. His greatest success came in the form of what came to be known as the iron-mercuty-iron coherer with the telephone detector which he developed in 1898. The clever use of mercury and the telephone detector increased the sensitivity of Bose's detector to levels not attainable with detectors in use at that time. Bose presented his new invention in a paper he presented to the Royal Society in 1899 (Fig. 3). In 1900, Bose had developed a unique detector using crystal of a lead mineral known as galena. It was perhaps the first use of a semiconductor as a detector which had great commercial potential.

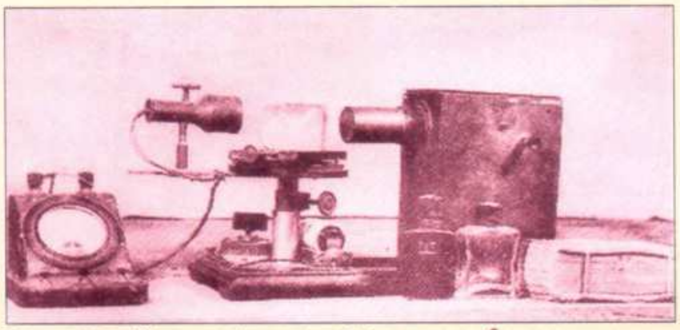


Figure 4: The Microwave Apparatus of Bose
Source: Jagadis Chandra Bose and Indian Response to western science by Subrata Dasgupta, (Original source: Bose Institute).

He was not only an acknowledged physicist, who was the first to generate extremely short radio waves that we call microwaves, in 1895, but he also studied their properties such as polarization using equipment he himself designed (Figure 4). Bose was also the first to use a 'horn' feed and 'waveguide' for his microwave experiments. Such 'horn' feeds and waveguides are widely used today in microwave and satellite links. Bose experimented with this device and published the results in the Proceedings of the Royal Society in November 1897. Indeed, it is an irony of fate that despite his remarkable inventions with which he contributed to the study of properties of electromagnetic waves, this great scientist of India, was somehow ignored in the annals of science.

Alexander Stepanowich Popov

The Russian Miracle

Alexander Stepanovich Popov was the son of a village priest. He received his early education in an ecclesiastical seminary school and planned to enter the priesthood. But in 1877 his interests changed to mathematics, and he entered the University of St. Petersburg, from which he graduated with distinction in 1883. Joining the teaching faculty of the university, he lectured in mathematics and physics in preparation for a professorship.

The first wireless telegraph message in Russia was successfully transmitted, received and deciphered by from a Russian Navy Ship 50 kilometers out to sea, all the way to his laboratory in St. Petersburg. Evidently he built his first primitive radio receiver, a lightning detector (1896), without knowledge of the contemporary work of the Italian inventor Guglielmo Marconi or Jagdis Chandra Bose. Popov constructed an apparatus that could register atmospheric electrical disturbances and, in July 1895, installed it at the meteorological observatory of the Institute of Forestry in St. Petersburg. In March 1896, he appeared before the St. Petersburg Physical Society and demonstrated the transmission of Hertzian waves – as they were then termed, between different parts of the University of St. Petersburg buildings.

The news of Marconi's work, as disclosed in his patent of June 1896, aroused Popov to fresh activity. Working in conjunction with the Russian navy, he effected ship-to-shore communication over a distance of 10 km by 1898. The distance was increased to about 50 km by the end of the following year, during which he had also visited wireless stations in operation in France and Germany.

Guglielmo Marconi

Although it is agreed that Popov's experimental work in connection with Hertzian waves is deserving of recognition, it has not been generally accepted that radio communication was actually invented by Popov. Thus, while it is true that historical research has brought to light indirect evidence that Popov successfully demonstrated the transmission of intelligible signals in March 1896, there is comparable evidence that Marconi demonstrated the transmission of intelligible signals at an even earlier date, though not before an audience of scientists.

In 1901 Popov returned to St. Petersburg as a professor at the electrotechnical institute, of which he was later elected director. He died five years later.

Forgotten Pre-history

One can only speculate as to why Bose was forgotten so far as historians of science are concerned. One reason may be that Bose abandoned his researches on radio waves around 1900. By the time of his trip to Paris and London in the autumn of 1900, he had other intellectual mattes in his mind. The normal and natural self-propagate that stems from a continuing, long-term research programme in a narrow area was, thus abruptly terminated when Bose moved on to other things.

A second and related factor is that even when a scientist changes fields, his or her presence in the original area may be sustained by that scientist's students and disciples. They not only continue their guru's programme, but help propagate his influence-through their own work. Scientific empires are built around schools of research. Bose did not, however, found a school of radio research – though decades later, an Institute of Radio Physics and Electronics would be established at the University of Calcutta's College of Science next door to Bose's own research institute. Nor did Bose ever co-author papers with others students or peers – in physics.

Third, he appeared to have taken no advantage of his patent. In the realm of invention and technology, patents speak most loudly in establishing priority and credit and, as the historiography of the field shows so starkly, never more so than in wireless telegraphy. It is possible that had Bose not been so profoundly indifferent to entrepreneurship, had he entered into a commercial collaboration with Alexander Muirhead as the latter had wanted and as Lodge would do, the record of his contributions to radio may have been more visible in the history of the technology.

Finally, one cannot quite ignore the 'Indian factor'. One can only wonder to what extent Bose's status as an outsider, a 'marginal man' – as a lone Indian in the hurly-burly of western scientific technology affected the seriousness with which others who came later would judge his significance in the annals of wireless telegraphy; and to what extent this may have contributed to his being forgotten, neglected or simply ignored. It would be naive and sentimental to believe that this was never a factor in the recognition of his work on radio waves.

Source: Jagadis Chandra Bose and Indian Response to western science by Subrata Dasgupta

Across the Atlantic

Guglielmo Marconi (25 April, 1874 - 20 July, 1937) was born at Bologna, Italy. Marconi was the second son of Giuseppe Marconi, a wealthy landowner, and his second wife, Annie Jameson, the daughter of an Irish whiskey distiller. His limited formal education, of early private tutoring followed by several years at the Leghorn lyceum, included special instruction in physics. His first wife, Beatrice O'Brien, was of an aristocratic Irish family. His second wife Maria Bezzi-Scali, belonged to the papal nobility. Marconi was always a devoted citizen of Italy, and frequently acted in an official capacity for his government. Chief among the many honours awarded him was the Nobel Prize for physics, which he shared with Carl Ferdinand Braun in 1909.

Marconi seems to have first learned in 1894 of Hertz's laboratory experiments with electromagnetic waves. He was immediately curious as to how far the waves might travel, and began to experiment, with the assistance of Prof. A. Righi of Bologna. Marconi began experimenting at his father's estate, using comparatively crude apparatus: an induction coil for increasing voltages, with a spark discharger controlled by a

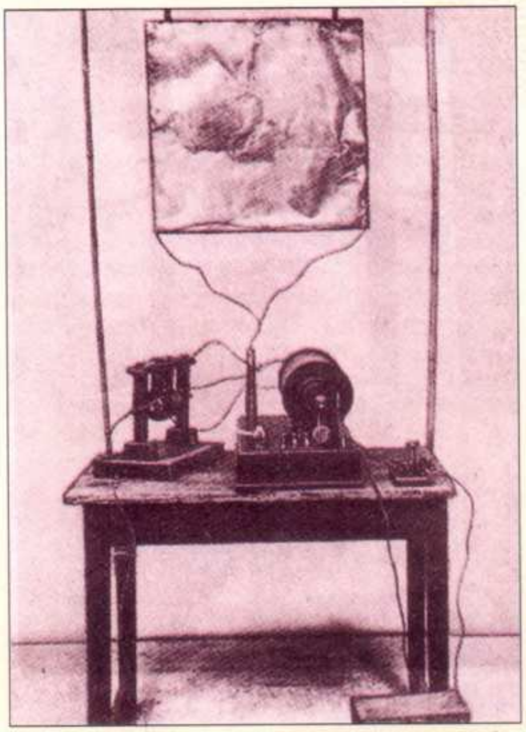


Figure 5: Marconi's apparatus of 1895, showing the metal plate aerial he first used to send wireless signals over a kilometer. On the far right corner of the table is the Morse tapper, connected to a battery on the floor, and to the induction coil (looking like a large cotton reel in the middle right of the table). The apparatus on the left of the table is the metal ball spark gap.

Morse key at the sending end and a simple coherer at the receiver. After preliminary experiments over a short distance, he first improved the coherer; then, by systematic tests, he showed that the range of signaling was increased by using a vertical aerial with a metal plate or cylinder at the top of a pole connected to a similar plate on the ground. The range of signaling was thus increased to about 2.5 km enough to convince Marconi of the potentialities of this new system of communication. During this period, he also conducted simple experiments with reflectors around the aerial to concentrate the radiated electrical energy into a beam instead of spreading it in all directions. At about the same time, he conceived of "wireless telegraph" communication through keying the transmitter in telegraph code. The apparatus he developed in 1895 to send wireless signals over a kilometer is shown in Figure 5.

Receiving little encouragement to continue his experiments in Italy, he went, in 1896, to London, where he was soon assisted by Sir William Preece, the chief engineer of the post office. Marconi filed his first patent in England in June 1896, and during that and the following year, gave a series of successful demonstrations, in some of which he used balloons and kites to obtain greater height for his aerials. He was able to send signals over distances of upto 6.5 km on the Salisbury Plain and to nearly 14.5 km across the Bristol Channel. These tests, together with Preece's lectures on them, attracted considerable publicity both in England and abroad, and in June 1897 Marconi went to La Spezia, where a land station was erected and communication was established with Italian warships (Figure 6) at distances of upto 19 km.

There remained much skepticism about the useful application and exploitation of radio waves. But Marconi's cousin Jameson Davis, a practicing engineer, financed his patent and helped in the formation of the Wireless Telegraph and Signal Company Ltd.(changed in 1900 to Marconi's Wireless Telegraph Company Ltd.). During the first years, the company's efforts were devoted chiefly to showing the full possibilities of radiotelegraph. A further step was taken in 1899 when a wireless station was established at South Foreland, England, for communicating with Wimereux in France, a distance of 50 km. In the same year British battleships exchanged messages at 121 km. In September 1899, Marconi equipped two U.S. ships to report to newspapers in New York City the progress of the yacht race for the America's Cup. The success of this demonstration aroused worldwide excitement and led to the formation of the American Marconi Company. The following year the Marconi International Marine Communication Company Ltd was established for the purpose of installing and operating services between ships and land stations.

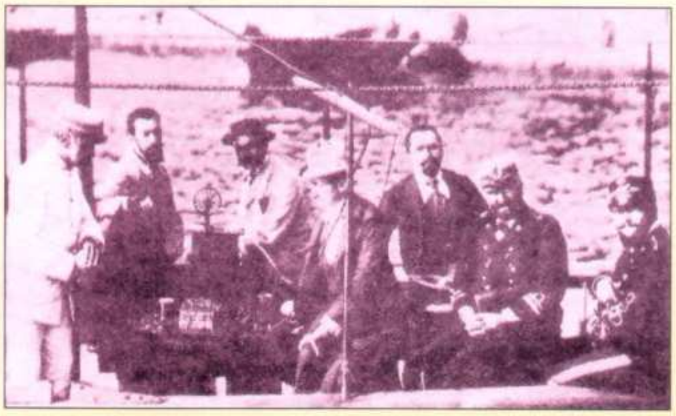
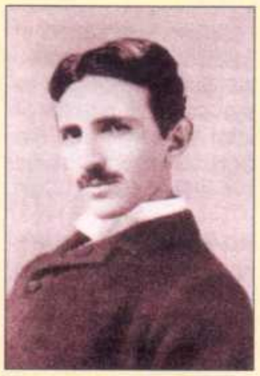


Figure 6: Marconi's first demonstration of his wireless to the Italian navy in 1897. In all his work in Italy, throughout the rest of his life, Marconi's untiring supporter and co-worker was his old boyhood friend, Luigi Solari.

Damped oscillations

The development of a great invention seldom occurs through one individual man, and many forces had contributed to the remarkable results then achieved. Marconi's original system had its weak points. The electrical oscillations sent out from the transmitting station were relatively weak and consisted of wave series following each other, of which the amplitude rapidly fell-so called "damped oscillations". A result of this was that the waves had a very weak effect at the receiving station, with the further result that waves from various other transmitting stations readily interfered, thus acting disturbing at the receiving station. It was due to the inspired work of Carl Ferdinand Braun from Germany that this unsatisfactory state of affairs was overcome. Braun made a modification in the layout of the circuit for the despatch of electrical waves so that it was possible to produce intense waves with very little damping. It was only through this that the so-called "long-distance telegraphy" became possible, where the oscillations from the transmitting station, as a result of resonance, could exert the maximum possible effect upon the receiving station. The further advantage was obtained that in the main only waves of the frequency used by the transmitting station were effective at the receiving station. It was only through the introduction of these improvements that the magnificent results in the use of wireless telegraphy could be attained.

Carl Ferdinand Braun



Nikola Tesla

Bose Vs Marconi

It is said that one of Marconi's childhood friends, Luigi Solari, who was a lieutenant with the Italian Navy, brought Bose's invention of iron-mercury-iron coherer with the telephone detector developed in 1898 to the notice of Marconi and built a slightly modified version of it for his, for which Marconi applied for a patent in September 1901. It is doubtful whether without the use of mercury coherer with telephone detector, Marconi could have ever succeeded in his trans-atlantic transmission which made him famous and got all the credit, including Nobel prize. Ironically, Bose, despite his pioneering role, remained unknown to the world.

One factor that perhaps went against Bose was his magnanimity. He was never tempted to patent his inventions for monetary profit, as is amply clear from his diary and letters written to his close friend, the poet Rabindra Nath Tagore. In 1900, Bose had developed a unique detector using a crystal of a lead mineral known as galena. It was perhaps the first use of a semiconductor as a detector and had great commercial potential. But Bose thought otherwise. He wrote in his diary on 13 November 1900: "As a practical outcome of my theory, the head of a great firm working on wireless telegraphy told me that the advantage derived from suggestions contained in that paper was beyond anything he could dream of. About my further ideas on the subject he begged me not to make things public but alllow him to take out patents. He told me lie could make great things out of my ideas. But I cannot find heart to give any part of my life for money making purpose."

In a letter to Tagore from London in 1900, he wrote: "The authorities of a wireless telegraphic concern (Muirhead & Co.) have received results beyond their expectations by producing instruments based on my theory. They are also requesting me to undertake further research on the matter." He expressed similar feelings in his subsequent letters to Tagore.

On the other hand, even during his lifetime, Marconi had often been accused of merely being a 'cribber' of other people's ideas. But his clever reply was: "I doubt very much whether there has ever been a case of a useful invention in which all the theory, all the practical applications and all the apparatus were the work of one man." He may have been right, but perhaps didn't realise that it is unethical not to acknowledge someone else's work.

– Based on an article: "The Real Inventor of Wireless" by Shyamal Gan and Biman Basu in Science Reporter

Great Triumph

Marconi's great triumph was, however, yet to come. In spite of the opinion expressed by some distinguished mathematicians that the curvature of the Earth would limit practical communication by means of electric waves to a distance of 150-300 km, Marconi succeeded on December 13, 1901 in receiving at St. John's, Newfoundland, signals

Nobel Prizes awarded for work with radio waves

The discovery of radiocommunication brought about a revolution in our lives and found applications in various fields of human activity. Here is a list of Nobel Prizes awarded for work with radiocommunication.

1909	Gugliolmo Marconi	Italy	in Physics for their contributions to the development of wireless telegraphy
	Carl Ferdinand Braun	Germany	-do-
1947	Sir Edward Victor Appleton	Great Britain	in Physics for his investigations of the physics of the upper atmosphere especially for the discovery of the so-called Appleton layer
1956	William Bradford Shockley	USA	in Physics for their researches on semiconductors and their discovery of the transistor effect
	John Bardeen	USA	-do-
	Walter Hosue Brattain	USA	-do-

transmitted across the Atlantic Ocean from Poldhu in Cornwall, England. This achievement created an immense sensation in every part of the civilized world, and though much remained to be learned about the laws of propagation of radio waves around the Earth and through the atmosphere, it was the starting point of the vast development of radio communications, broadcasting, and navigation services that took place in the next 50 years, in much of which Marconi himself continued to play an important part.

During a voyage on the U.S. liner Philadelphia in 1902, Marconi received messages from distances of 1,125 km (700 miles) by day and 3200 km (2000 miles) by night. He thus was the first to discover that, because some radio waves travel by reflection from the upper regions of the atmosphere, transmission conditions are sometimes more favorable at night than during the day (this circumstance is due to the fact that the upward travel of the waves is limited in the daytime by absorption in the lower atmosphere, which becomes ionized – and so electrically conducting – under the influence of sunlight).

In 1902, Marconi patented the magnetic detector in which the magnetization in a moving band of iron wires is changed by the arrival of a signal causing a click in the telephone receiver connected to it - similar to the one developed by Jagadis Chandra Bose. During the ensuing three years, he also developed and patented the horizontal directional aerial. Both of these devices improved the efficiency of the communication system. In 1910 he received messages at Buenos Aires from Clifden in Ireland over a distance of approximately 9650 km, using a wavelength of about 8000 metres. Two years later, Marconi introduced further innovations that so improved transmission and reception that important long distance stations could be established. This increased efficiency allowed Marconi to send the first radio message from England to Australia in September 1918.

In 1916, during the world war I, he saw the possible advantages of shorter wave lengths that would permit the use of reflectors around the aerial, thus minimizing the interception of transmitted signals by the enemy and also effecting an increase in the signal strength. Marconi continued the work on wavelength 15 metres. In 1923, on board his steam yacht Elettra, he received signals from a distance of 2250 kilometers from a transmitter of 1 kilowatt of Poldhu. Thus began the development of short wave wireless communication that, with the use of the beam aerial system for concentrating the energy in the desired direction, is the basis of most modern long - distance communication. In 1932, using very short wave length of about 0.5 metres, Marconi installed a radio telephone system between Vatican city and the Pope's palace at Castel Gandolfo.

Saving Lives at Sea

In 1909, a liner cruising the Atlantlic collided with another ship. Devastated, and with ruptured electricity supplies, the stricken ships lurched helplessly in fog-bound waters. But the wireless on the liner remained in tact. The calls for help were here heard forty eight kilometeres away on shore. What trimph when a liner finally found the floundering ships hidden by the thick mists, and rescued nearly seventeen hundred people! Marconi's name was linked throughout the world with saving lives at sea.

The power of Marconi's wireless was proved again, pitifully, in April of 1912. On the fifteenth, the largest, most luxurious, "unsinkable" ocean liner yet built sank to the bottom of any icy sea and fifteen hundred people died. The only survivors were those saved by the wireless. It was Titanic's maiden voyage. At 11:40 p.m., on the night of Sunday, April 14, 1912, she struck on iceberg. Two hours forty minutes later, she disappeared beneath the frozen waters of the North Atlantic. The Carpathia had heard the Titanic's wireless call for help. But she was sixty miles away. She arrived two hours after the black waters had swallowed the great liner, and rescued over seven hundred survivors.

Indeed the year 1912 was also a year of personal disaster for Marconi. A road accident in Italy left him with a badly-injured right eye. The doctors believed that this posed danger for the other, the good eye, and they removed the damage one, but he returned to work after a few months.

[In Part II of this article, we shall discuss the development of the vacuum tube diode and triode – or audion as it was called by its inventor Lee de Forest . This was a major event which was responsible for the rapid development and growth of radio communication. Yet another fundamental discovery during the golden decade was the discovery of the Ionosphere, which acts as a mirror for radio waves. The radio waves transmitted from ground are reflected back to the earth by the ionised layers of the ionosphere making long distance radio communication possible. This is how Marconi could receive radio signals from England to New Foundland despite the curvature of the Earth. We shall also briefly discuss the growth of radio communication over the century since then. However, it must be remembered that no one person "invented" wireless electronic communications, even though Guglielmo Marconi for over 100 years has been called the inventor of radio. Marconi did take the ideas and inventions of others and put them together in a workable form to allow people to send messages through the air, invisibly, on radio waves.]

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John Desmond Bernal : The "Great Sage"

❑ Subodh Mahanti

In the last issue of the newsletter we had published an article on G.N. Ramachandran, where it was mentioned that the decision of Ramachandran to work on collagen structure was influenced by a casual remark of J.D. Bernal made during his visit to Chennai then Madras. This prompted us to publish an article on Bernal. Moreover the year 2001 also happens to be the birth centenary of Bernal

Whether true or false others must judge; for the firmest conviction of the truth of a doctrine by its author, seems, alas, not to be the slightest guarantee of truth

Charles Darwin

Get the best information in the minimum quantity in the shortest time, from the people who are producing the information to the people who want it, whether they know they want it or not.

J.D. Bernal

The story opens in 1936 when I left my hometown, Vienna, for Cambridge, England, to seek the Great Sage. He was an Irish Catholic converted to Communism, a mineralogist who had turned to X-ray crystallography: J.D. Bernal. I asked the Great Sage : "How can I solve the secret of life". He replied : "The secret of life lies in the structure of proteins, and there is only one way of solving it and that is by crystallography." We called him the sage because he knew everything from history to physics. His conversation was the most fascinating of anyone I have ever come across. Actually what had attracted me to Cambridge were the lectures of a young organic chemist in Vienna who told us students of the work being done in the laboratory headed by Frederick Gowland Hopkins, one of the founders of biochemistry.

Max Ferdinand Perutz, the Nobel Laureate

Bernal was a committed Marxist and a member of the British Communist Party. Bernal's interest and involvement in social and political issues began about the same time he initiated his scientific studies at Cambridge. He was the most respected and loved of Western intellectual communists. Today Bernal's views as a hardcore communist may not be appealing, if not, totally irrelevant. The world has drastically changed since Bernal's time. But then Bernal's political activity was just one aspect of his fascinating personality. Above all Bernal was a great teacher who could influence and inspire a large number of students, who later made pioneering contributions in their respective fields. Bernal was an original thinker. He was a visionary scientist. In fact, Bernal was one of the most influential scientists of his generation.

J.D. Bernal

By all accounts John Desmond Bernal was a dazzling thinker and talker. His contemporaries called him "Sage" as he was considered to be uncommonly wise. He had been the most brilliant thinker of his time. It was his encyclopaedic knowledge, his breath of vision, and his conscientious activism that most singled him out rather than his scientific contributions. Charles Percy Snow (1905-80), the English novelist and physicist, thought that Bernal was "perhaps the last of whom it could be said, with meaning, that he knew science'. Julian Huxley (1887-1975), the English biologist and writer, thought Bernal to be the wisest man in Britain. Joseph Needham described him as one of the best minds of their generation.

Julian Huxley

Bernal was born on 10 May 1901 in Nengh, County Tipperary, Ireland. About his family background, C.P. Snow wrote: "Like almost everything else about him, his family origins were unusual. His father was what used to be called a squireen, somewhere between a farmer and a catholic Irish squire. His mother was an American, educated at Stanford, who wrote some interesting journalism and had considerable resemblances to a Henry James expatriate heroine.

There were, as happened throughout Bernal's life, legends about this heredity, for he was a mythopoetic character about whom stories, and inaccurate statements, of fact massively accumulated. For private circulation there once appeared a loving document about him entitled *The Irish Jew*".

At the age of 10 he was sent to boarding school, Stonyhurst, a Jesuit establishment, in England. He stayed there for two years before coming back to Ireland. It is said that the reason for leaving the school was that he was dissatisfied with the scientific education there. But after an interval, Bernal was sent again to England, to another public school, Bedford. At eighteen Bernal won a major open scholarship in mathematics to Emmanuel College, Cambridge. After getting a second class in Part I of the Mathematical Tripos, Bernal took Part I of the Natural Sciences Tripos in chemistry, mineralogy and geology in which he got a first class. Then he proceeded to Part II physics and got another second class. He became obsessively absorbed with crystallography and undertook an elaborate painstaking research problem in this field. He derived 230 space groups by means of Hamiltonian

F.G. Hopkins

quaternions, an astonishing piece of work for an undergraduate.

This work enabled him to get a research post at the Royal Institution in London in 1923. He was to work with William Henry Bragg (1862-1942), who alongwith his son William Lawrence Bragg (1890-1971), developed X-ray analysis of the atomic arrangement in crystalline structure. Within a short period, after joining the Royal Institution, Bernal established himself as one of the most accomplished crystallographers in England. At the instance of Bragg he started to work on the structure of graphite. His analysis of the structure of graphite was a classic piece of distinctly laborious work. He also created a diagram for interpreting X-ray photographs which is now called "Bernal Chart". In 1927 he came back to Cambridge to join the newly established department of crystallography. It was Arthur Hutchinson, the professor of Mineralogy, who persuaded the university to establish a department of crystallography and advertise for an Assistant Director of Research. The period from 1927 to 1937 in Cambridge was the most creative period of Bernal's scientific life. At Cambridge he worked on the structure of vitamin B (1933), pepsin (1934), vitamin D_2 (1935), the sterols (1936) and the tobacco mosaic virus (1937).


William Henry Bragg

In 1937 he was appointed as professor of physics at Birkbeck College of the London University. He succeeded his great contemporary Patrick Maynard Stuart Blackett (1897-1974), who built an improved cloud chamber used to photograph tracks of a nuclear disintegration and cosmic ray shawer discovered the positron and got Nobel Prize in physics in 1908. Here Bernal made notable contribution on the structure of liquids and inspired others to do important work.


PMS Blackett

The Bimolecular Research Laboratory, the brain-child of Bernal was opened by Sir Lawrence Bragg on 1 July 1948. In the words of Bernal : "The setting up of the Birkback College Biomolecular Research Laboratory was made possible by the generous gift of the Nuffields Foundation which enabled the college to equip and man the two houses in which the present research center is lodged. The old research laboratory of the physics department where work along these lines was carried out on a small scale before the war had been destroyed by enemy action and would in any case have been much too small for the scale of work at present in hand". The three objectives of the laboratory were :

1. "To work on the structure of proteins".
2. "To develop the necessary electronic and computing skills needed for the faster and better analysis of these proteins".
3. "To understand the fundamental nature of the constituent active materials in cements and the nature of their reaction with water".

The establishment of this laboratory is the testimony of Bernal's great vision. In those days when there were no proper hardware and computer it was extremely difficult to determine a precision structure. It took a team of 2 or 3 people 3 years to determine a precision structure. With the development of computer the same could be achieved in less than 0.1 second on a Intel based P2 running at 400 MH_2.


William Lawrence Bragg

Bernal used to live in a flat on the top floor of the laboratory to avoid wasting of time in commuting. Moreover, staying there he could check up easily on the activities of his students in their offices on the lower floors. Besides scientists, many eminent peace campaigners were entertained in his flat above the laboratory including Pablo Picasso (1881-1973), who painted a mural on the wall of the flat. The mural, the only one ever executed by Picasso in England, was saved from demolition.

Bernal was one of the principal creators of molecular biology. Bernal was the founder of protein crystallography. Indeed, the field of molecular biology was sterile until Bernal's observation that protein crystals could be studied only in the wet state. Bernal was the first crystallographer to obtain clear images of X-ray diffraction by protein in 1934. To avoid dehydration during the experiment, Bernal had placed the protein crystals in a capillary tube that was closed at both ends. While the images obtained by Bernal did not lead to a three-dimensional description of protein structure, but these images were clear enough to confirm the macromolecular nature of proteins. Thus Bernal demonstrated the possibility of resolving the three dimensional structure of proteins. Among his students were Dorothy Crowfoot Hodgkin (1910-94), who determined the structure of the vitamin B12 molecule through X-ray crystallographic analysis and got Nobel Prize in 1963; Rosalind Franklin (1920-58), who played a major part in the discovery of the structure of DNA by J.D. Watson and Francis Crick; Aaron Klug (1926-), who developed crystallographic electron


Pablo Picasso

microscopy, elucidated biologically important nucleic acid-protein complexes and got Nobel Prize in 1982; and Max Perutz, who worked on the structure of haemoglobin and got Nobel Prize in 1962.

Bernal's role in establishing the field of protein crystallography will be obvious from the following remarks of Perutz :

"In 1934 J.D. Bernal and Dorothy Crowfoot (now Hodgkin) at the Crystallographic Laboratory in Cambridge, England, placed a crystal of pepsin in an X-ray beam to see if it gave a diffraction pattern. It was an unpromising experiment because it had already been proven that protein crystals give no diffraction pattern. This was only to be expected because the great German chemist Richard Willstatter and his pupils had shown that proteins are colloids of random structure, and the enzymatic activity of J.H. Northrop's crystalline pepsin did not reside in the protein, which was but inert carrier for its real, yet to be isolated, active principle. Besides, even if the German chemist were wrong, and a diffraction pattern were obtained, it would clearly be impossible to deduce from it structures of molecules as larger and complex as proteins.

Pablo Picasso's drawing on the wall of Bernal's Flat

Contrary to all reason, or perhaps because they had not read the literature, Bernal and Crowfoot discovered that pepsin crystals did give an X-ray diffraction pattern. It was made up of sharp reflections that extended to spacing of the order of inter atomic distances, showing that pepsin was not a colloid of random coils, but an ordered three-dimensional structure in which most of its 5,000 atoms occupy definite places. **Their observation opened the subject of protein crystallography.** (emphasis not in original).


Dorothy Hodgkin

In the historical development of science, Bernal has a leading place. It was not so much for his actual contribution. As stated above he demonstrated that if treated correctly a protein crystal could retain its order during irradiation by X-rays and the three-dimensional structure could be worked out from the information scattered become of X-rays. His students went on to solve the structures of haemoglobin and other key materials. The application of X-ray crystallography to structural analysis of complex molecules revolutionised our understanding of biology.

Bernal was the originator of the study of viruses by X-ray crystallography. This is because Bernal could visualise the utility of X-ray diffraction in determining the structure of virus and he and Isador Fankuchen (1905-64) had taken the first X-ray photograph of Tobacco Mosaic Virus and Tomato Bushy Stunt Virus in the 1930s. Bernal also conducted research into the origin of life and the structure and composition of the Earth's crust.

It can be said that Bernal's work with Dorothy Hodgkin, Isidor Fankuchen and others on X-ray crystallography effectively started molecular biology. Bernal had anticipated that in the geometry and physical structure of such molecules must lie some of the explanations of the origin of life and the way the living process works. That Bernal was right became amply clear when Watson and Crick unravelled the structure of the DNA— the double helix.

Science was absolutely central both to Bernal's social thinking and to his philosophical thinking. The scientific method encompassed the whole of his life. Bernal viewed science as a social activity, integrally tied to the whole spectrum of other social activities; economic, social and political. According to Bernal, the cause of science was inextricably intertwined with the cause of socialism. He believed that "In its endeavor science is communism". Bernal had proposed that government support and planning of scientific research would be the best means of improving the condition of human life. For Bernal there was no philosophy, no social theory, no knowledge independent of science. Science was the foundation of it all. Bernal's philosophy of science was in the tradition of Engel's. The important thing about Engel's concept of nature, as Bernal saw it, was that Engle's saw it as a whole and as a process. **Bernal founded altogether a new discipline called "Science of Science".** Its objective was to overcome overspecialization and to achieve the unity of science. "It placed science within the context of the whole of human and cosmic evolution. Its central idea was the process of transformation, and its scope was the whole range of human experience".


Rosalind Franklin

Bernal's own writings included : *The World, the Flesh and the Devil* (1929); *The Social Function of Science* (1939); *The Freedom of Necessity* (1949); *The Physical*

Basis of Life (1950); *Science and Industry in the Nineteenth Century* (1953); *Science in History* (1954); *World Without War* (1958); *Origin of Life* (1967) and *The Extension of Man--Physics Before the Quantum* (1972).

Bernal collaborated in the 1940 monograph on steroids with Isidor Fankuchen and Dorothy crowfoot Hodgkin, in which crystal data were listed for more than eighty sterol derivatives. "The Social Function of Science", which Bernal wrote became the most celebrated piece of work. Many a people were greatly influenced by it. During the same period when he was involved in groundbreaking research on the crystals of biologically important substances like sterols, proteins and viruses.


Aaron Klug

Jerry Rabetz, historian and philosopher of science, wrote in his essay, the *Marxist Vision of J.D. Bernal*: "With a magnificent sweep, his surveys run through the history, sociology, political critqiue and the future of science. His was a coherent vision, one deriving from a great tradition of progressive thought about science, which first matured to the mid - 18th century but was, I think, and enriched and deepened by Bernal's own intense concern for science and democracy ... Bernal's *Social Function of Science* was perhaps the last of the great testaments of science in which a person of broad intelligence and philosophical depth could argue coherently the social problems of the world, and of science itself, could be solved simply by the methods and approach of science".

Eugene Garfield wrote: "Through my career-- in fact, since my early adolescence – I have been fascinated by the history and sociology of science. Indeed, it is quite likely that a book my uncle gave me at the end of my freshman year in high school – John D. Bernal's *The Social Function of Science* was the spark that ignited my incipient interests in research and influenced my eventual decision to make a career for myself in the science community".


Richard Willstatter

In *Science in History* Bernal gave a general review of the achievements of science as a whole, revealing its philosophical significance and role in human history. In *World Without War* he discussed the prospects of the peaceful use of scientific discoveries for the benefit of humanity.

Towards the end of his life Bernal was not happy about the way science was being done. Jerry Rabetz had asked Bernal in the early 1960s in London at a British Society of History of Science meeting : "How do you feel now nearly 25 years after you published your great work on the social function of science? How do you feel about science especially now since the lessons have been absorbed?"

Bernal replied: **"Oh, it's all a racket. Back in the old days we all loved science, we were in it just because we loved it and it was a great fun. But now you have all kids, it is just careers and they don't care. All they want is more money and more personnel. It is terrible".**


Max Perutz

Bernal was deeply involved in wartime activities during the Second World War. After the Germans invaded Russia, he threw all his energies into aggressive war. Under the aegis of the Ministry of Home Security, Bernal carried out with Solly Zuckerman an important analysis of the effects of enemy bombing. He became an Advisor to Lord Louis Mountbatten (1900-79), the Chief of Combined Operations. He went to the Quebec Conference and helped plan the invasion of Europe. After the War, Bernal worked for establishing peace on the globe.

Bernal died, at the age of seventy on 15 September 1971. Bernal was an active, often restless man but unfortunately for some years before his death he had lost almost all muscular movement. He could not speak even with amplifier except those of his nearest connections who could catch his tone of voice.

We would like to end this brief write-up on Bernal by quoting C.P. Snow on Bernal : "..all through this life he had a curious lack of the artistic impulse to perfect a piece of work and sign his own name underneath. He started so many things, and stayed to finish only a few. Others could do the final work. He was part of a collective enterprise. In some depths of this temperament he was self-centred, but also he was the most unselfish of men. It was that combination, as rare as the somewhat similar one of Einstein's, which made him different from most of the human species". Certainly we need many more Bernals today – to inspire the younger generation and to generate ideas worthy of pursuing.


J.H. Northrop

I would like to thank Prof. Santosh K. Kar, Centre for Biotechnology, Jawaharlal Nehru University for giving me the book, *Science Is not a quite Life : Unravelling the Atomic Mechanism of Haemoglobin by Max Perutz* and Dr. A.K. Mathur of NISTADS for providing some information on Barnal.

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Recent developments in Science & Technology

World's fastest silicon - based transistor

IBM has built the world's fastest silicon - based transistor. This transistor is able to operate at 210 GHz and this is 80 percent faster than previous technology. Earlier transistor was able to operate only upto 200-GHz speed. The speed of the transistor generally depends upon the distance electricity must travel within the device. IBM researchers were able to shrink this distance in so called heterojunction bipolar transistors in which electrons flow along a vertical path rather than taking the horizontal route in conventional transistors. IBM expects, that within two years, the transistor will drive chips used in communication equipment to 100 GHz - five times faster than today's chips. The little super-silicon transistors still have a way to go before they can switch quickly enough to keep up with the theoretical limit of fiber optics communication.

Source : Scientific American, September 2001

Moon Over Saturn

Saturn family has gotten bigger. Researchers using 11 different telescopes around the world have reported that they have found 12 new moons, ranging from 6 to 32 kilometers in diameter and orbiting saturn in highly eccentric paths. These tiny moons seem to be groups of three or four, suggesting that they are remnants of larger bodies that fractured, probably by collisions. The latest finding reported in the July 12, 2001 issue of Nature, journal brings saturn's satellite brood to 30. Six major moons and 24 minor ones.

Source: Scientific American, September 2001

Solar powered Aircraft

Helios is world's first solar powered aircraft which successfully completed 18 hours of test flight over the pacific ocean on July 2001. The unmanned aircraft of National Aeronautics and Space Administration (NASA) is powered by 62,000 solar cells and manages to reach an altitude of 24.4 km.

The ultralight aircraft has a single translucent curved wing covered with 180 square meter of solar panels which are capable to generating 40 kilowatt of power. Only 10 kilowatt of energy is needed to keep the plane aloft. Two ground based pilots controlled the flight by remote control using desktop computer. Helios has a 34 meter wings span and flies at a top speed of 300 km per hour. It is a prototype of an aircraft which scientists plan to use as a flying satellite capable of keeping aloft for months.

Source: PTI News

New Superconductor

Lots of research is going on in the field of material science. Superconductivity is one of the major focus of this stream. Last year carbon-60 was discovered as a superconductor. Now it is found that magnesium diboride (MgB2) becomes superconductor at a temperature about 40k. This almost doubles the transition temperature held by simple inter metallic compounds -- previously held by niobium germanur at a temperature of 23.20k.

Even though Jun Akimistu and colleagues at Aoyama Gakuin University in Tokyo were not working on search for new superconductors, yet they discovered, quite by chance that MgB2 loses its electrical resistance. This is the most recent discovery in the field of superconductivity. Earlier, Noble Prize had been given to George Bednorz and Alex Muller in 1986 for the discovery of the cuprate super conductors.

Source: Physics World, April 2001

Genome of Hepatitis C Virus

Indian scientists have successfully sequenced the complete genome of Indian strain of Hepatitis C virus. This is a landmark achievement by Indian scientist. In India, Hepatitis C has infected more than 20 million people and is the major cause of liver cancer. The breakthrough will help to tackle this dreaded disease. Till now only 36 microbes have been completely sequenced in the world and hence the achievement of researchers from Deccan College of Medical Sciences and Allied Hospital, Hyderabad, alongwith Shanta and Sudarshan Biotech firms is creditworthy.

Source: PTI News

Compiled by : Kapil Tripathi

VP News ......

Tihu is a prominent centre of trade and commerce in Assam, bordering two districts; Kamrup and Barpeta. It has traditionally been at the forefront of academic and social activities of the state. It is also the most vibrant centre of Vigyan Prasar activities with the highest concentration of VIPNET clubs.

Vigyan Prasar accepted the invitation of Shri Pabindra Deka, Member of the Legislative Assembly, Patacharkucchi Consistency, Assam, to hold a one-day Awareness Meeting at Tihu on 02 October 2001 to invigorate the popular science activities in this region. A prominent NGO called 'Aaranyak' from Guwahati and a local voluntary body called 'Tihu Dakshinanchal Sahitya Sanskritik Gosthi' lent full support to this programme which was sponsored by Shri Deka under the Local Area Development Scheme (LADS).

Tihu College, the venue of this meeting, saw a large gathering of old and new faces of science communication of Assam, besides a host of students, teachers and activists from educational institutions and clubs. Prof. Lohit Talukdar, Principal of the College, presided over the meeting. The speakers included Dr. Subodh Mahanti and Shri Arup Kumar Misra from Vigyan Prasar, Dr. Bibhab Talukdar from Aaranyak, Smt. Nirmali Hazarika from the Board of Secondary Education, Assam, Shri Pathak, Ex-Principal of Tihu College and Shri Dhrubajyoti Kalita of the host agency. Active resource persons of DPEP, research scholars and young teachers from the Gauhati University and its affiliated colleges, a team of 10 members from LIDSA, an NGO of Mangaldoi, and almost all VIPNET club coordinators of the district interacted with the resource persons in the meet. This initiative is expected to provide a major boost-up to VP programmes in Tihu and its neighbouring areas, besides sending a signal to many other legislators of Assam to organise similar events for the connoisseurs of science.

Dr. Bibhab Talukadar, Shri Arup Kumar Misra, Prof. Lohit Talukdar, Dr. Subodh Mahanti and Shri Jaideep Baruah (L-R) interacting with the participants.

A section of the participants listening to the speakers with attention at Tihu College Auditorium.