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Monthly Newsletter of Vigyan Prasar

DREAM 2047

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VP News

S&T Communication through Satellite Radio

A beginning was made to utilise the WorldSpace Satellite Digital Radio System for Science and Technology communication by Vigyan Prasar on May 06, 2002. A function was organised on this day at Department of Science & Technology, New Delhi, to mark the occasion. To begin with, Dr. V.B. Kamble, Director, VP, welcomed the guests. The invitees included representatives from Government/non-Government organisations, scientific coordinators and individuals. Dr. D. Venugopal, Vice President (Operations), WorldSpace, Bangalore, delivered a talk on WorldSpace radio and its applications. The inaugural address was delivered by Prof. V.S. Ramamurthy, Secretary, Department of Science & Technology, GoI, followed by the WorldSpace Radio demonstration-cum-experimental broadcast. The broadcast consisted of talks by Prof. V.S. Ramamurthy, Dr. Narender K. Sehgal, former Chief of NCSTC and founder Director of Vigyan Prasar, and Dr. V.B. Kamble, on various aspects of science communication. The talks were interspersed with slides. The slides were received prior to the audio broadcast from satellite in the form of digitized data. The demonstration was followed by interaction with the audience.

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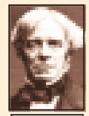

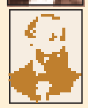

The broadcast was heard by about 45 VIPNET Science Clubs who have been given WorldSpace Radio Receivers for organising listening sessions for the members of the clubs on topics related to science and technology. Reports have started pouring in from the clubs regarding their reactions/suggestions on the use of WorldSpace Radio for S&T communication.

(Sitting from Left) Dr. D. Venugopal, Vice-President, (Operations) WorldSpace, Dr. Narender K. Sehgal, Former Director, Vigyan Prasar, and Prof. V.S. Ramamurthy, Secretary, DST

VP in association with WorldSpace organised demonstration of Radio in 4 schools of Delhi namely Mother's International School (Arvindo Marg), Heritage School (Vasant Kunj), APJ School (Saket), DTEA (Lodhi Estate) and Cambridge International School, Noida. Teams of officials from VP and WorldSpace conducted demonstrations alongwith an introductory talk on digital Satellite Radio Communication. The demonstrations in schools were received with great enthusiasm. The schools have expressed a desire to initiate activities utilising WorldSpace Radio for education in general and S&T in particular. They expressed keenness to associate themselves in production of programmes/software for WorldSpace Radio. Incidentally, VP is planning WorldSpace Radio demonstrations in other Metros of the country as well.

The experimental programme produced by VP was recorded at Electronic Media Production Centre of Indira Gandhi National Open University. VP is grateful for the cooperation extended by its

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

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Editor: Dr. V.B.Kamble

Back with a Bang

Only a few months ago we celebrated the centenary of the wireless message sent by Guglielmo Marconi from England to New Foundland across the Atlantic. Indeed, that historic event marked the beginning of the process of transforming the world into what we today call a global village. Radio communication has since contributed in a number of ways to the growth and development of the society. There is no gainsaying the fact that over the decades, besides pushing the frontiers of science further ahead in various fields, communication technology has brought the people together separated through geographical and cultural barriers, and helped bring harmony in the society. This is especially true with a vast country like ours with a multiplicity of languages and cultural diversity. .

The website of All India Radio mentions that the first radio programme in India was broadcast by the Radio Club of Bombay in June 1923. It was followed by the setting up of a Broadcasting Service that began broadcasting in India in July 1927 on an experimental basis at Bombay and Calcutta simultaneously under an agreement between Government of India and a private company called the Indian Broadcasting Company Ltd. When India became independent, the AIR network had only six Stations located at Delhi, Bombay, Calcutta, Madras, Lucknow and Tiruchirapalli with a total complement of 18 transmitters - six on the medium wave and the remaining on the short wave. Radio listening on the medium wave was confined to urban limits of these cities. There were a mere 2,75,000 receiving sets at the time of Independence.

Development of semiconductor technology in the 1950s made radio as common an item as a wrist watch. A transistor radio set in one's hand was a familiar a sight in the 1960s and 1970s resembling mobile telephone of today! Now there are about 100 million estimated radio sets in the country, that is one radio set for about ten persons. The broadcast scenario has also drastically changed covering nearly cent per cent of country's population. Radio was virtually pushed into the backyard as a result of the phenomenal growth of television, especially after the organization of Asian Games in 1982 in the country.

But, not quite true. Despite the scores of satellite channels and direct-to-home television having been available in the 1990s, radio staged a come-back in the form of FM radio. FM services were then limited only to metros, and that too mainly for entertainment. The range was limited to 80-100 kilometres. It is only recently that Indira Gandhi National Open University has employed FM radio for educational purposes.

Now, a century after Marconi and half a century after Arthur C. Clarke (who first conceptualized a system of geo-synchronous satellites for global communication), the WorldSpace digital radio system is poised to revive the good old radio through the satellite medium. What is remarkable is the fact that it can cover the remotest and the most interior parts of a vast country like India. It is powered by three geo-synchronous satellites for digital radio communication spaced at 120^0 apart. Indeed, it is a worldwide satellite digital audio system and also a multimedia system that uses these communication satellites to deliver signals directly into home to portable hand-held receivers. In effect, it is a direct-to-home radio. Live access to news, educational broadcasts, and entertainment from all around the world through its unique global relay capability are the remarkable features of this system. Since the broadcast is digital, it is possible to download the data files into a personal computer. It is even possible to transmit and receive slides / visuals, store them in a personal computer, and synchronize with the audio broadcast for a full fledged lecture-cum-demonstration. Further it is possible also to access selected websites on the internet.

Use of radio for science and technology communication, however, is relatively a new phenomenon. A 13 - part radio serial on Method of Science in 14 Indian languages in 1989, and another 144 -part radio serial on Human Evolution broadcast in 18 Indian languages simultaneously by all stations of All India Radio during 1991-1994 were true landmarks in the history of science and technology popularization in the country. Vigyan Prasar is putting in efforts to utilize the WorldSpace satellite digital radio system for science and technology popularization in the country in association with WorldSpace. Vigyan Prasar hopes to connect the VIPNET science clubs spread throughout the country, through the WorldSpace satellite radio. Several of them are situated in the far-flung areas of the country. In the days to come, Vigyan Prasar plans to extensively utilize the new powerful technology of satellite radio communication for science and technology popularization, for education on and management of natural disasters and so on, along with other established technologies. Although a satellite radio receiver is a relatively expensive affair today, costing seven to twelve thousand rupees, in the days to come its cost is likely to come down drastically - as is the case with every new technology. Only a few years ago, all radios used to have only AM, now almost all radios come with built-in AM and FM. Within a foreseeable future, radios will include a satellite channel in addition to AM and FM. Indeed, radio is back with a bang!

❒ **V. B. Kamble**

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Michael Faraday

One of the Greatest Discoverers of All Time

❐ Subodh Mahanti

Nothing is too wonderful to be true, if it be consistent with the laws of nature and in such things as these, experiment is the best test of such consistency.

Michael Faraday

The more we study the work of Faraday with the perspective of time, the more we are impressed by his unrivalled genius as an experimenter and a natural philosopher. When we consider the magnitude and extent of his discoveries and their influence on the progress of science and industry, there is no honour too great to pay to the memory of Michael Faraday - one of the greatest discoverers of all time.

Ernest Rutherford

Much has been written about Faraday and much more will be written and read not only because of the enormous significance of his discoveries and the profusion of historical material, but also because his life has a romantic 'rags to riches' quality and nearness to perfection which will forever be an inspiration to those whose love for science may seem to be unmatched by opportunity or formal education.

George Porter

He (Faraday) was by any sense and by any standard a good man; and yet his goodness was not of the kind that make others uncomfortable in his presence. His strong personal sense of duty did not take the gaiety out of his life…his virtues were those of action, not of mere abstention…

T. Martin, biographer of Michael Faraday

The story of Michael Faraday's life is one of the most romantic stories in the annals of science. It will continue to inspire in countless ways. Faraday rose from a book-binder's apprentice to become one of the greatest scientists of all time. He is acknowledged as one of the greatest thinkers of his time. He was a true pioneer of scientific discoveries. His discoveries have had a spectacular effect on successive scientific and technological developments.

Faraday's contributions to human society have been outstanding. Physicists and chemists alike look back on Faraday as a worthy pioneer. However, he is best known for his contributions in physics to the understanding of electricity and magnetism. Among his many path-breaking discoveries were induced electricity (1831), electrostatic induction (1838), the relationship between electricity and magnetism (1838) and between electricity and gravity(1851), hydro-electricity (1843) and atmospheric magnetism (1851). Faraday became one of the greatest scientists of all time because of his interest in science, his strong motivation and his remarkable perseverance.

Michael Faraday

He was a great builder of instruments. Faraday was a great populariser of science. He initiated popular science lectures for children and general audiences at the Royal Institution. Faraday was one of the greatest lecturers of his time. His Christmas lectures for the children at the Royal Institution became legendary. These lectures, Faraday intended, to 'amuse and entertain as well as educate, edify and above all, inspire.'

Faraday, the man, was as great as Faraday, the scientist. Throughout his life Faraday remained a kind and humble person. He was totally unconcerned with honours. While refusing for the second time the presidency of the Royal Society he commented to his successor at the Royal Institution and his biographer, John Tyndall (1820-93): "I must remain plain Faraday to the last; and let me tell you, that if I accepted the honour which the Royal Society desires to confer upon me, I would not answer for the integrity of my intellect for a single year".

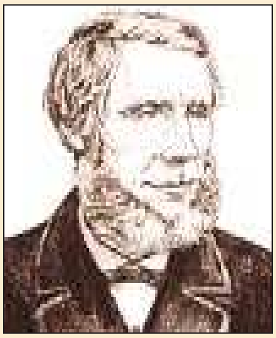
He was always eager to practise his science to the best of his ability. Faraday had refused to accept the offer of professorship from the University College of London. He had also refused a knighthood and the presidency of the Royal Society, not once but twice. Faraday had strong views on awards. He said : "I have always felt that there is something degrading in offering rewards for intellectual exertion, and that societies or academies, or even kings and emperors should mingle in the matter does not remove the degradation".

Michael Faraday was born on September 22, 1791 at Newington, Surrey, England. His father James Faraday was a blacksmith who came from Yorkshire in the north of England. His mother Margarate Hastwell was the daughter of a farmer. Early in 1791 Faraday's parents moved to Newington, which was then a village outside London, where Faraday's father hoped that work would be more plentiful.

The Faradays were members of a sect known as the Sandemanian, which originated in the 1730s in a breakaway from the Scottish Presbyterians (having to do with Church of Calvinistic-protestant origin governed by presbyters or elders). The sect never had more than a few hundred followers. In that sense it was an obscure sect. Its members did not try to spread its message. They believed that those who belonged to their community would naturally find a way to them. The sect demanded total faith and total commitment. The members of the sect organised their daily lives through their literal interpretation of the Bible. The followers of this sect considered themselves as the true followers of the Church and consequently they believed that their salvation was assured. This kind of belief made it easier for them to make peace with the hardship of the present day world. They were not interested in worldly goods and wealth. Faraday's religious belief gave him a strict moral code. Faraday was a devout member of the Sandemanian sect. Faraday's scientific world view was deeply influenced by the message of the Bible. Here we quote Jim Baggott on Faraday's religious belief and its influence on his work. Baggott wrote in *New Scientist* (1991): "Faraday found no conflict between his religious belief and his activities as a scientist and philosopher. He viewed his discoveries of nature's laws as part of the continual process of 'reading the book of nature', no different in principle from the process of reading the Bible to discover God's laws. A strong sense of the unity of God, and nature pervades Faraday's life and work."

Humphrey Davy

Faraday attended a day school and he received only the most basic education - to read, write and count that is the traditional 'three Rs' of **r**eading, (w)**r**iting and (a)**r**ithmatic. Given his family background nothing much could be expected. The Faradays were desperately poor. When Faraday was thirteen years old he had to find work to help the family finances. In 1804 he was employed running errands for George Riebau, a bookseller and bookbinder. Riebau's shop was located in Blandford Street, close to where the Faradays lived. One of Faraday's main duties as an errand boy was to deliver newspapers to those who used to read newspaper on loan basis and fetch them back to the shop. Riebau was a kind employer. After a year as an errand boy Faraday was taken on by Riebau as an apprentice bookbinder. Faraday learned the trade of book binding well as is evident that in later years he bound many volumes for himself and many of them are still in existence. For most of part of this apprenticeship Faraday lived on Riebau's premises. Thanks to the magnanimity of Riebau, Faraday and also his two other fellow apprentices working at the time got the opportunities to develop their own interest. Faraday not only bound books but he also read them. Among the many books that he read during his apprenticeship, two books had great influence in shaping his future scientific career. This is evident from a letter that he wrote to his friend De La Rive. Faraday wrote :



John Tyndall

"… I entered the shop of a bookseller and bookbinder at the age of thirteen, in the year 1804, remained there eight years, and during the chief part of my time bound books. Now it was in those books, in the hours after work, that I found the beginning of my philosophy.

There were two that especially helped me, the "Encyclopaedia Britannica" from which I gained my first notions of electricity and Mrs. Marcet's "Conversation on Chemistry", which gave me foundation in that science.

Do not suppose that I was a very deep thinker, or was marked as a precocious person. I was a very lively imaginative person, and could believe in the "Arabian Nights" as easily as in the "Encyclopaedia". But facts were important to me, and saved me. I could trust a fact, and always cross-examine an assertion. So when I questioned Mrs. Marcet's book by such little experiments as I could find means to perform, and found it true to the facts as I could understand them, I felt that I had got hold of an anchor in chemical knowledge, and clung fast to it. Thence my deep veneration for Mrs. Marcet - first as one who had conferred great personal good and pleasure on me; and then as one able to convey the truth and principle of those boundless fields of knowledge which concern natural things to the young, untaught, and inquiring mind."

During his period of apprenticeship with Riebau he came in contact with the City Philosophical Society, an organization established by a group of young men interested in self-improvement. The Society organised a series of evening lectures on natural philosophy (the modern day equivalent of science). Faraday became a member of this Society in 1812. Membership cost a shilling. Faraday's subscription was paid by his brother Robert. For two years Faraday attended lectures on a variety of scientific topics. At the Society Faraday made new friends. Among them were Benjamin Abbott and Edward Magrath. With Abbott he carried on extensive correspondence as an exercise in improving his skill at written communication. Magrath helped him in his grammar, spelling and punctuation. Faraday's interaction with Magrath continued for seven years.

Count Alessandro Volta

Faraday prepared four bound volumes of his notes taken during the meetings of the Society. Faraday's employer Riebau encouraged him in his attempt to study science. In fact Riebau used to show these volumes to his customers. One of Riebau's young customers (some Mr. Dance) was so much impressed with the Faraday's notes that he borrowed these volumes for the purpose of showing them to his father. Apparently the elder Dance was also impressed as evident by the fact that he sent tickets to Faraday to attend lectures given by Humphrey Davy at the Royal Institution. Faraday attended four lectures at the Royal Institution. He was fascinated by the lectures delivered by Davy. He took careful notes which he wrote up, with accompanying drawings of the experiments demonstrated by Davy and bound. Davy's lectures reinforced Faraday's interest in science.

He spent seven years serving his apprenticeship with Riebau. In a letter 1813 Riebau described how Faraday spent his days as apprentice : "After the regular hour of business, he was chiefly employed in drawing and copying from the Artist's Repository, a work published in numbers which he took in weekly … Dr. Watts' *Improvements of the Mind* was then read and frequently took in his pocket, when he went an early walk in the morning, visiting some other works of art or searching for some mineral or vegetable curiosity… His mind ever engaged besides attending to bookbinding which he executed in a proper manner.

Dominique Francois Arago

His mode of living temperate, seldom drinking any other than pure water, and when done his day's work, would set himself down in the workshop… if I had any curious book from my customers to bind with plates, he would copy such as he thought singular or clever…"

Faraday's apprenticeship with Riebau ended on 7 October 1812, a couple of weeks after his 21st birthday. Faraday was desperately trying to get an employment where he could pursue his interest in science. It was not only difficult but looked impossible to change his profession of bookbinding to science. In any case he had no formal education. But Faraday was determined to pursue his interest in science. He wrote to Sir Joseph Banks, the then President of the Royal Society, asking him how he could become involved in scientific work. However, Banks did not bother to reply. In the meantime Faraday started working as a bookbinder for a Mr. De La Roche. Unlike his earlier employer Mr. De La Roche was a difficult master. Without being discouraged by not receiving a reply from Banks Faraday wrote to Humphrey Davy. He also sent him the notes he had taken at Davy's lectures. Davy not only replied to Faraday but also arranged a meeting. However, nothing much happened. Davy advised Faraday to keep working as a bookbinder saying, "Science is a harsh mistress, and in a pecuniary point of view but poorly rewarding those who devote themselves to her service."

Andre Marie Ampere

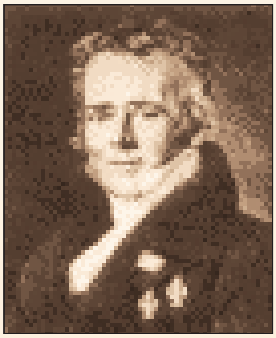
But then in February 1813, an incident happened that turned a bookbinder's apprentice into one of the greatest scientists of all time. One Mr. William Payne who was working as laboratory assistant at the Royal Institution got involved in a public brawl. As a result he was dismissed from his job at the Royal Institution. Davy sent for Faraday and offered him the job. Davy's recommendation of Faraday was presented to the managers of the Royal Institution at a meeting on the 18th March 1813. The recommendation read as follows :

"Sir Humphrey Davy has the honour to inform the managers that he has found a person who is desirous to occupy the situation in the Institution lately filled by William Payne. His name is Michael Faraday. He is a youth of twenty-two of age. As far as Sir H. Davy has been to observe or ascertain, he appears well fitted for the situation. His habits seem good; his disposition active and cheerful, and his manner intelligent. He is willing to engage himself on the same terms as given to Mr. Payne at the time of quitting the institution."

Faraday was offered the job at a guinea (a former English gold coin, last minted in 1813, equal to 21 shillings) a week with accommodation provided in two rooms at the top of the Royal Institution building. Faraday was yearning for such an offer and so he readily accepted the job though the salary was much less than he was earning as bookbinder. In October 1813 Davy planned to undertake a scientific tour of Europe and he invited Faraday to go along with him as his assistant and secretary. For going with Davy on foreign tour Faraday was required to resign his post at the Royal Institution. However, it was guaranteed that Faraday would get back his job on his return to England. Faraday agreed. Before this tour Faraday had never traveled more than 12 miles from the centre of London. During the tour which lasted for 18 months Faraday had also acted as Davy's part-time valet and servant. Mrs. Davy who was a class-conscious woman and believed in keeping servants firmly in their place, treated Faraday badly. Inspite of inconveniences Faraday enjoyed his trip thoroughly. Faraday maintained a journal in which he recorded his experiences. He got the opportunity to meet the key figures of science including Count Alessandro Volta (1745-1827), Andre Marie Ampere (1775-1836), Joseph Louis Gay-Lussac (1778-1850), Dominique Francois Arago (1786-1853), Friedrich Heinrich Alexander von Humboldt (1769-1859) and Georges Leopold Chretien Frederic Dagobert Cuvier (1769-1832). While travelling from laboratory to laboratory across Europe, Faraday got the opportunity to perform experiments and attend lectures and in this

Joseph Louis Gay-Lussac

process he received the education he had never had. By all means the trip had profound influence on Faraday. To quote Faraday's biographer T. Martin : "These eighteen months abroad had taken the place, in Faraday's life, of the years spent at university by other men. He gained a working knowledge of French and Italian; he had added considerably to his scientific attainments, and had met and talked with many of the leading foreign men of science; but, above all, the tour had been what was most valuable to him at that time, a broadening influence."



Hans Christian Oersted

On his return to London, in 1815, Faraday was re-engaged at the Royal Institution as an assistant. His duties mainly involved with chemical experiments in the laboratory. He also began lecturing on chemistry topics at the Philosophical Society. He published his first paper in 1816 on caustic lime from Tuscany. It was sent to Davy by the Duchess of Montrose. The paper was published in '*The Quarterly Journal of Science*' of the Royal Institution - the precursor of the *Proceedings of the Royal Society*. As his chemical capabilities increased, he was given more responsibility. In 1825 he replaced the seriously ailing Davy in his duties directing the laboratory at the Royal Institution. In 1833 he was appointed to the Fullerian Professorship of Chemistry – a special Chair created for him.

Faraday made numerous discoveries both in chemistry and physics. His research work was of highly technical nature. To understand his discoveries satisfactorily one would require a detailed knowledge of chemistry and physics. Among the most important discoveries of Faraday were discovery of benzene, magneto-electric induction, laws of electro-chemical decomposition, the magnetization of light and diamagnetism. Commenting on the achieve-ments of Faraday, John Tyndall said: "Taking him for all and all, I think it will be conceded that Michael Faraday was the greatest experimental philoso-pher the world has ever seen; and I will add the opinion, that progress of future research will tend, not to dim or diminish, but to enhance and glorify the labours of this mighty investigator."

Friedrich Heinrich Alexander von Humboldt

Faraday's early career was notable for its chemical research. His only original book *Chemical Manipulation* appeared in 1827. He made new chemical compounds. In 1822 he made the first steel alloy. In 1823, Faraday was the first to liquefy a gas, chlorine. In 1825 he discovered benzene (C_6H_6) while examining the residue collecting in cylinders of illuminating gas. He called the new compound 'bicarburet of hydrogen because he took its formula to be C_2H. It was Faraday who synthesised the first chlorocarbons. Faraday was one of the best chemical analysts of his time.

Although Faraday began his scientific career as a chemist, he also became intrigued by the nature of electricity and magnetism which began to be recognized as different aspects of a single phenomenon at the beginning of the 1820s. His life's major work was the series of *Experimental Researches on Electricity* published over 40 years in *Philosophical Transactions* in which he announced his many discoveries including electromagnetic induction (1831), the laws of electrolysis (1833), and the rotation of polarised light by magnet (1845).

In 1820 Hans Christian Oersted (1777-1851) had discovered the first link between electricity and magnetism. Oersted found that when a magnetic compass is held near a wire that carries an electric current the needle of the compass (which is a tiny bar magnet) is always deflected to a point at right angles to the wire. The experiment implied that an electric current produces a magnetic force that influences the compass needle.

When Faraday read of Oersted's experiment he like other members of the scientific community became very excited and decided to investigate it on his own. In September 1821 Faraday demonstrated "electromagnetic rotation" by showing that a current-carrying wire could be made to rotate around a fixed magnet. This was the first primitive electric motor. Sixty years after of Faraday's demonstration electric trains were running in Germany, UK and the USA.

Georges Leopold Chretien Frederic Dagobert Cuvier

Unfortunately this experiment triggered off a rift between Faraday and his mentor Davy that was never healed. Davy thought that Faraday had overheard a discussion between Davy and William Hyde Wollaston (1766-1828). Faraday admitted that he may have gotten a start from the discussion between Davy and Wollaston but his apparatus was substantially different and the effect demonstrated by Faraday was completely different from the effect predicted by Wollaston. History has put its stamp on the originality of Faraday.

After discovering the electromagnetic rotation Faraday wanted to convert magnetism into electricity that is the reverse of what Oersted did–electricity was converted into magnetism. In 1831 Faraday demonstrated that when a magnet is moved past a wire, or pushed into the mount of coil of wire while the magnet is moving it creates an electric current in the wire. This discovery formed the basis of the electricity generator or dynamo, in which electricity is produced by rotating magnets that move swiftly past coils of wire. Faraday found that by combining mechanical motion with magnetism he could produce electric current.

He detected the presence of electric current when he moved the coil of wire over the magnet but when he let the magnet just sit motionless inside the coil of wire there was no electric current. This was the principle of electromagnetic induction or the basic principle of electric generator or dynamo. Joseph Henry (1797-1878), an American physicist, had also come up with an excellent demonstration of this idea. However, he never published it. On the other hand, Faraday pursued his work with extraordinary single-mindedness and got the credit for its discovery. Henry had accepted Faraday's originality.

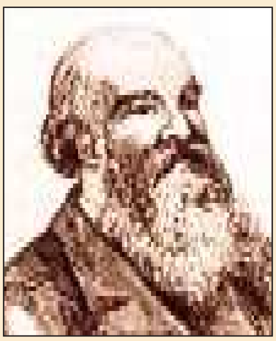
It is said that the then British Prime Minister Sir Robert Peel (1788-1850) after seeing a demonstration of the dynamo effect asked Faraday what use the discovery was. Faraday replied, "I know not, but I wager that one day your government will tax it." Faraday himself did not try to develop the practical applications of his discoveries. Rather he became deeply interested in understanding how electricity and magnetism are related to each other.

Joseph Henry

It was Faraday who showed that the various types of electricity – static, voltaic, animal and thermoelectric – were the same.

Faraday's work on electrolysis had far reaching implication. In 1934, he formulated his famous laws of electrolysis which govern all that happen in electrochemical technology and industry.

Faraday's pioneering research in electrochemistry created the necessity of coining some appropriate terms to describe his work. With the help of his friend Whewell Faraday coined a number of terms which are being commonly used till date: anode (from the Greek *ana* for 'up' and *hodos* for 'road', cathode (from the Greek, *Kata* for 'down'), ion (for '*wanderer'* in Greek) and consequently anion or cation. He also coined the terms `electrolyte' and `electrode'.



James Prescott Joule

It was Faraday who created the notion of a 'field' to describe electrical and magnetic forces. Since his childhood Faraday had a profound belief in the inter-connection and unity of natural forces and phenomena. Faraday said : "I have long held an opinion, almost amounting to conviction, in common I believe with many other lovers of natural knowledge, that the various forms under which the forces of matter are made manifest have one common origin; or in other words, are so directly related and mutually dependent, that they are convertible, as it were, one into another, and possess equivalents of power in their action'. He thought that his field theory and his findings on the interrelatedness of magnetism, electricity and motion contributed to his vision of unity of natural forces and phenomena. Faraday's belief in the fundamental unity of nature was vindicated by subsequent works of James Prescott Joule (1818-89), Joseph John Thomson (1856-1940), Harmann Ludwig Ferdinand von Helmholtz (1821-94), Rudolf Julius Emmanuel Clausius (1822-88) and James Clerk Maxwell (1831-79).

In spite of the technical nature of his research work Faraday was remarkably gifted as an expounder of science to popular audience. Faraday introduced a series of Friday Evening Meetings under the aegis of the Royal Institution. These evening meetings grew into an institution in their own rights, the Friday Evening Discourses. These Discourses reported the latest developments in science to a general audience, who were required to pay a certain fee for attending the discourses. Faraday often turned out to be the speaker in those discourses. Between 1825 and 1862, when he retired, Faraday gave more than a hundred of the Friday lectures. The tradition continues to this day.

In 1826 Faraday started the famous lecture course at the Royal Institution — a series of six Christmas lectures for children. He gave 19 of these lectures courses. For most of these lectures only the notes exist except a couple of lecture courses namely "*The Chemical History of a Candle*" and *"Lectures on Various Forces of Matter"* were taken down in short hand and later published. They have become classics. Together, the Friday Evening Discourses and the Christmas lectures have introduced generation of people to the wonder of science. Faraday was not a born lecturer. He assiduously prepared to make himself one of the great lecturers of all time. Here we quote Faraday's views on the art of lecturing.

"As practised by the Society, lecturing is capable of improving not only those who are lectured, but also the lecturer. He makes it, or he ought to make it, an opportunity for the exertion of his mental powers, that so by using he may strengthen them; and if he is truly in earnest, he will do as much good to himself as to his audience.

Joseph John Thomson

A lecturer should exert his utmost effort to gain completely the mind and attention of his audience, and irresistibly make them join in his ideas to the end of the subject. He should endeavour to raise their interest at the commencement of the lecture and by a series of imperceptible gradations, unnoticed by the company, keep it alive as long as the subject demands it..... A flame should be lighted at the commencement and kept alive with unremitting splendour to the end.

A lecturer should appear easy and collected, undaunted and unconcerned, his thoughts about him and his mind clear for the contemplation and description of his subject. His action should be slow, easy and natural, consisting principally in changes of the posture of the body, in order to avoid the air of stiffness or sameness that would be otherwise unavoidable.

The most prominent requisite to a lecturer, though perhaps not really the most important, is a good delivery; for though to all true philosophers science and nature will have charms innumerable in every dress, yet I am sorry to say that the generality of mankind cannot accompany us one short hour unless the path is strewed with flowers.

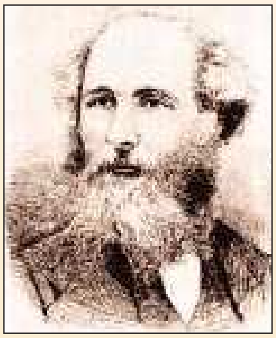
Harmann Ludwig Ferdinand von Helmholtz

"Never to repeat a phrase"

"Never to go back to amend"

"If at a loss for a word, not to ch-ch-ch or eh-eh-eh, but to stop and wait for it. It soon comes, and the bad habits are broken, and fluency soon acquired."

With respect to the action of the lecturer, it is requisite that he has some, though it does not here bear the importance that it does in other branches of oratory; for though I know of no other species of delivery that requires less motion, yet I would by no means have a lecturer glued to the table or screwed to the floor. He must by all means appear as a body distinct and separate from the things around him, and must have some motion apart from that which they possess."



Rudolf Julius Emmanuel Clausius

Throughout his life Faraday worked at the Royal Institution. Faraday felt indebted to the Institution. In fact without Faraday the Royal Institution would not have survived. He made every effort to earn money for the Institution's survival. For his gratitude to the Institution he did not accept the offer from the University of London of the Chair of Chemistry in 1827. While declining the offer he wrote:

"I think it a matter of duty and gratitude on my part to do what I can for the good of the Royal Institution in the present attempt to establish it firmly. The Institution has been a source of knowledge and pleasure to me for the last fourteen years, and though it does not pay the salary for what I now strive to do for it. Yet I posses the kind feeling and good-will of its authorities and members, and all the privileges it can grant or I require ; and, moreover, I remember the protection it has afforded me during the past years of my scientific life…I have already (and to a great extent for the sake of the institution) pledge myself to a very laborious and expensive series of experiments on glass."

Only a man like Faraday can take such a stand in life. Faraday joined the Royal Institution in 1813. He gave his last Friday Evening Discourse, on 20 June 1862, and his last connection with the Royal Institution was severed in 1865. The Royal Institution was also his home since 1813 to 1862 when he moved to a house at Hampton Court given by Queen Victoria at the suggestion of Prince Albert. We are told that Faraday did not have the money to repair the house to make it habitable. On knowing this the Queen paid for the renovations as well.

Faraday died on 25 August 1867. Following his wishes he was buried quietly in Highgate cemetery. His grave is not far from that of Karl Marx. Faraday's headstone bears the following non-descript inscription.

MICHAEL FARADAY

Born 22 September 1791

Died 25 August 1867.

On the occasion of the bicentennial anniversary (1991) of birth, Faraday was honoured in his home country with commemorative postage stamp and a special first-day cover. His portrait and signature replaced William Shakespeare on 20 pounds note. A special memorial service was held in Westminster Abbey.

James Clerk Maxwell

We would like to end this article by quoting Faraday. "A philosopher (read scientist) should be a man willing to listen to every suggestion but determined to judge for himself. He should not be biased by appearances, have no favourite hypothesis, be of no school and in doctrine have no master. He should not be a respecter of persons, but of things. Truth should be his primary object. If to these qualities be added industry, he may indeed hope to walk within the veil of the temple of nature."

Books on Faraday and his works

Agassi, Joseph, *Faraday as a Natural Philosopher*, Univ. of Chicago Press, Chicago, 1970.

Crookes, William, (Editor) *A Course of Six Lectures on the Chemical History of a Candle: (Vigyan Prasar has brought out a reprint of this book.* It is priced as Rs. 35/-).

Gooding, David & James Frank A.J.L. (editors), *Faraday Rediscovered*: Essays on the Life and Work of Michael Faraday (1791-1867). Stockton Press, London ,1985.

Jones, Bence, *The Life and Letters of Faraday*(2 Volumes) Longmans, Green, London, 1870.

Randell, Wilfrid L., *Michael Faraday*, Parsons, London, 1924.

Tyndall, J., *Faraday as a Discoverer*(4th Edition), Longmans, Green, London, 1868.

Williams, Pearce L., *The Origins of Field Theory*, Random House, New York, 1966.

Williams,Pearce L., *Michael Faraday*, Basic Books, New York, 1967.

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Discovery of Anthrax Bacillus

P.K. Mukherjee

The battle against the 'curse of God'

Robert Koch, renowned for spotting the bacillus of tuberculosis and isolating it, was also responsible for identifying *Bacillus anthracis*, the anthrax bacteria which was in the news soon after the terrorist attack on the twin towers of American World Trade Centre (WTC), on September 11, 2001.

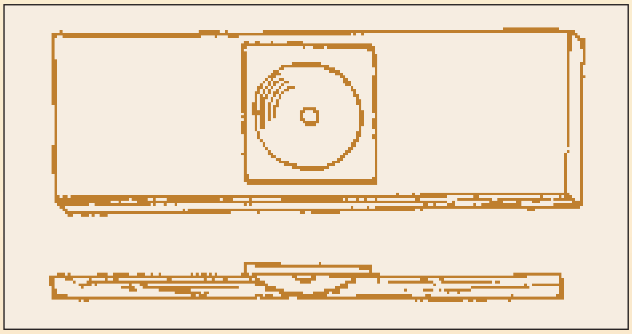
Through the 'eye' or the microscope

Born in 1842 in Germany, Robert Koch graduated as a doctor from the University of Gottingen. His one youthful passion was to roam around the world, see new places and meet new people. Adventure and a free life of the hobo attracted him. But, how could he realize his dream? 'I shall become a ship's doctor, float over the seven seas, and gaze with my own eyes at the seven wonders of the world', he said to himself. However, this dream of Koch was not to materialize so soon.

Robert Koch

In 1866, Koch became a doctor in a lunatic asylum in Hamburg. Confined to the four walls of the living inferno, distracted by the shouts of half-idiots and the wails of maniacs, it was not surprising that the news of the amazing discoveries of Louis Pasteur regarding microbes never reached him. At this time he happened to meet Emmy Fraatz, and between them began a long courtship that culminated in their marriage.

After his marriage with Emmy, Koch settled down as a practising doctor in the prosaic villages of Prussia. In 1870, he moved to Wallstein - a small village in East Prussia. To rid Koch of his dull routine life, his wife purchased a microscope and gifted it to him. Koch began to study the weird doings in the microbe world with the help of this microscope. There was nobody to teach him. He had only to depend upon his own wits, and of course the very reliable eye of the microscope. Infatigably, Koch examined everything. He could not rest by night nor stop thinking about the microbe world during the day.



The 'hanging drop'

The 'curse of God'

Meanwhile, the scared and worried farmers started coming to Koch. They would bring with them stories about the 'curse of God' that visited their flocks of sheep and cattle. All too suddenly, a healthy lamb full of the unbounded joy of life would fall ill and lie down, morose and ailing. But this was only the first blow. Swifter and swifter came more blows. Not one lamb here, not another there, but sheep and cattle too would die in hundreds. Sometimes, even the farmer himself would catch the disease. Boils would erupt on his body, and then fever swiftly would do the rest with the dead farmer's blood turning a ghastly black.

Dragging out the glass sliders and putting them under his microscope, Koch would focus his attention on drops of blood from the cattle killed by the disease. Slide followed slide in endless succession. His wondering eyes would behold among the tiny 'greenish globules', peculiar objects that resembled sticks - short and long sticks - all linked together into threads, infinitely finer than the thinnest thread of silk.

Koch would pause for a moment to think: 'Could these sticks be the germs that cause anthrax! He decided to insert these sticks into the blood-stream of healthy animals, and then watch for anthrax to appear. However, realising that cows and sheep were too costly for his meagre purse, Koch fell back on mice for his experiments. But, he even did not possess the much needed syringe. So, he decided to use slivers of wood. He cleaned and heated the slivers to kill possible microbes living on them. He then dipped them into the blood of an animal which had died from anthrax. By making a cut below the tail of a healthy mouse he inserted these slivers into this cut. The next morning Koch found the mouse dead; its body had turned black.

By placing the mouse on dissection-board and cutting open its abdomen, Koch found the spleen of the mouse enlarged and black. He also found the blood of the dead mouse swarming with the sticks and threads he had witnessed before. Surely, he could not have inserted more than a hundred germs with the wooden slivers. However, to his utter surprise, they had indeed grown into millions. This was clear evidence that not only were those sticks the cause of anthrax, but they could also grow and multiply at a rapidly alarming rate. 'But I must watch them grow. With my microscope I cannot look inside a mouse which is alive. Then how shall I do it? puzzled Koch.

Anthrax bacilli

The 'hanging drop'

The problem defied solution for days. But, at last his ingenious brain found the answer. By taking a clean glass slide he put it though a burning flame to destroy all microbes. He then placed on it a thin strip of tissue from the diseased spleen of an anthrax victim along with the liquid from the eye of a freshly slaughtered ox. Koch then stuck the slide and its contents with vaseline to a thick block of glass in which a hollow had already been scooped out. Koch put this simple contrivance, which he called 'hanging drop', under his microscope and watched intently. He had to be patient with his microscope. But, ultimately, his patience bore fruit and he could see millions of tiny rods multiplying at a furiously rapid rate.

Koch repeated his 'hanging drop' experiment every day for a week. Each day he would take a drop from the last 'hanging drop' and place it in the fresh ox-eye fluid. Each day the bacillus multiplied a billion fold. After a week, he had the eight generation of the original mouse-spleen bacillus he sealed in the first 'hanging drop'. By placing a drop of this on fresh wooden slivers Koch infected a healthy mouse. Once again, the bacilli multiplied, this time on the body of the mouse, and killed it. Koch next repeated the experiment a number of times with guinea pigs, rabbits and sheep. There was no room left for doubt anymore. Yet, he had not finished with the anthrax bacillus. He had to find out how the bacillus traveled from a sick animal to a healthy one.

Caricature of Koch raising bacteria and fungi

The conquest

By accident, Koch stumbled on the explanation. One day he came across a 'hanging drop' that had remained forsaken for twenty-four hours at the temperature of a mouse's body. He found that the sticks and threads had developed tiny beads and glittered like silver. He dried the 'hanging drop' and put it away safely on a shelf. After a month or so, he found the dried beads as lustrous as before. He put fresh ox-eye fluid on the dried beads, and lo! the beads once again changed into the bacilli of anthrax. 'So, this is the way they keep alive!' Koch thought. The microbes had dried up, but not before the beads or the spores have had time to form. And once the spores had formed the bacilli became immortal. Gaining entry into the blood-stream of a healthy cow or sheep they would again get transformed into living active bacilli.

Thus, the battle against the 'curse of God' was conquered at last. Overnight Koch became famous with his name splashing in the science journals of all European countries. Koch had established beyond the vestige of a doubt that microbes are the hidden agents of disease and death. He had proved that a single microbe is sufficient to begin a scourge that could wipe out a population of thousands of cattle.

Koch went to attend a meeting specially convened in his honour by Professor Cohn, the famous botanist of Germany of his times. He did not lecture the learned men of science who had gathered to hear him; he just showed them what he found by repeating his experiment in front of them. The practical Koch, slightly stuttering in his speech, told them his conclusion: 'It is possible to root out the anthrax disease if a few elementary precautions are taken. All animals that die of anthrax must be destroyed at once. If they cannot be burnt, they should be buried deep in the ground where the earth is so cold that the bacilli cannot transform themselves into the tough long-lived spores. Our cattle can be saved from this lurking danger; but not applying leaches and feeding them with pills and potions. I have shown you the enemy. Let us exterminate the race of this bacillus.'

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National Centre for Software Technology :
Focussing on Relevant Research

❒ Dilip M. Salwi

The very word IT (Information Technology) brings the names of several prestigious institutes and organizations like CDAC, CDOT, NIIT, CMC, etc, to the mind but not the name of the Mumbai-based National Centre for Software Technology (NCST) despite the fact that it is one of the premier organizations dealing the computer software technology in the country. The reason is simple. The Centre has never tried to publicise its activities through various media. It has been slowly, steadily and quietly building up its infrastructure, knowhow, activities and facilities in all computer related fields with special emphasis on software. In the process, it has achieved several feats known only to the professionals in the field. "We've not created any supercomputing architecture," said its fair, tall and broad-shouldered Associate Director Dr. S. P. Mudur, smiling. "But we've made dents in several carefully selected areas, namely, database, networks and internet, knowledge-based systems, software engineering, graphics and multimedia, and educational technology. We aspire to make our centre world class in these fields".

The simple yet elegantly designed two-storey off-white building of the centre comes up suddenly amidst a well-known market area of the posh Juhu colony of Mumbai known for its beautiful beach. In fact, one could never imagine that a computer centre of national importance could be located opposite restaurants, bars, sweets and garment shops! But as one enters the centre, the whole scenario changes to quietness and serenity. "This centre has originated from a ten year UN Project at the Tata Institute of Fundamental Research, Mumbai," said the bearded Senior Administrative Head of the Centre, K. Chandran, giving the history behind its creation." When the project ended, about 40 computer scientists associated with the project went on to set up this centre in 1985 in view of the country's growing need of computer software". Dr. S. Ramani, a leading name in computer software today, became its first Director.

A view of the National Centre for Software Technology

"We three - Dr. Ramani, Dr. P. Sadanandan, the present Director, and myself - made the initial working plan of the centre," added Dr. Mudur. "From the very beginning, our mandate was very clear: we will conduct research of relevance to the needs of the country, make it a revenue-generating research centre and at the same time maintain the TIFR culture of excellence in frontline research". Initially, the centre was proposed to obtain only 50 per cent of its expenditure from the Government. However, over the years it has been able to earn more than 75 percent of its recurring expenses, which, for an autonomous society and a public trust that the centre is, is highly commendable.

From the beginning, the centre has laid emphasis on three major areas, namely, R & D, education and training, and high technology support to industry and business. It has played a pioneering role in the Ministry of Information Technology's ERNET project, has commissioned and managed India's first internet gateway and has today become the internet domain name registrar for the country. It has also worked in collaboration with the reputed U.S. Microsoft Corporation for developing Window 2000's capacity in the Indian regional languages.

The softwares designed by the centre are being used by organizations such as Aeronautical Development Agency, Indian Oil Corporation, NELCO, HTL, MTNL, Corporation Bank and ONGC. Besides it has done pioneering work in the areas of intelligent information retrieval, multilingual computing, 3 D graphics, virtual reality and on-line testing for campus recruitment. "The reason for our success in both R & D and consultancy to industries" said Dr. Mudur proudly, "is that we don't have a strong hierarchical structure. We believe that ideas have to flow through academic informality". The centre's staff is encouraged to publish research papers, present papers in conferences and symposia, write monographs and text books.

No country can sustain her growth and development without continuous creation of quality manpower. Since its inception, the centre has been introducing advance and post-graduate courses for continuing education for improving software and internet manpower in the country. It offers several one year post-graduate diploma courses. Admission to these courses are made on the basis of an all India competitive test called 'Competence in Software Technology' held every year. Today, this test is considered a benchmark in Indian industry and is even used as a filter for admission to several higher level courses at IIT-Mumbai and other institutions. Every year, about 10,000 students appear for the test. The classes for the PG diploma courses are held every Saturday/Sunday and practicals are conducted round the clock at the centre almost like shift duties due to the tremendous response to the courses.

"We've no separate staff for research and teaching," said Dr. Mudur, "Our staff do frontline and industrial research as well as teach and train students". To date, nine students have received Ph.D. degree for the frontline research conducted at the centre. In fact, the famous Infosys Technologies has instituted two fellowships for doing Ph.D. at the centre.

In its short life-span of 15 years, the centre has grown up both in its scope and relevance. It has won several national and international awards and recognitions for its contributions. It is all set for expansion. It is building two more campuses at Navi Mumbai and Bangalore, with hostel facilities for students. The salient feature of the former will be a National Resource Centre for On-line Learning and a Software Engineering Research Laboratory at the latter. "We can't achieve world standards," said Dr. Mudur, "unless we've excellent human resonance in working. We intend to build that in our working in all our campuses".

National Centre for Software Technology, Gulmohar Cross Road No. 9, Juhu, Mumbai - 400 049; website : www.ncst.ernet.in.

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Recent Developments in Science and Technology

Protein Research Could Lead to New Malaria Drugs

Despite the existence of number of treatment strategies, malaria still kills 2.7 million people each year. What is more, the parasites that cause the deadly disease are becoming increasingly resistant to drugs currently available, making the development of new medications all the more urgent. A report published in the journal *Science* claims that scientists have identified a key difference in how humans and the malaria-causing parasite *Plasmodium* regulate a single enzyme. The findings could aid future efforts to design drugs to combat malaria.

Plasmodium is sensitive to drugs that target the enzyme dihydrogolate reductase (DHFR), which humans also produce. Previous research had suggested that because of affinity of parasite DHFR drugs could kill the parasite yet leave the host unaffected Yet some drugs that did not exhibit such selectivity were still toxic only to *Plasmodium.* Pradipshinh K. Rathod and Kai Zhang of the University of Washington has explained this discrepancy. They report that the parasite cannot rapidly replenish the enzyme once a drug binds to it because the messenger RNA necessary to produce DHFR is also bound to the enzyme itself. A human cell, in contrast, can rapidly generate surplus quantities of the protein if the drug accidentally attacks it because the messenger RNA is released when the drug binds to DHFR in humans.

The researchers hope the new findings, coupled with the ongoing sequencing of the malaria genome, will lead to more selective drug design to combat the disease. Says Rathod: “You can have all the maps, you can have all the guns, you can have all the firepower, but if you don’t know where the important targets are, it’s a waste.” In a commentary published in the same issue of the journal, Daniel E. Goldberg of the Howard Hughes Medical Institute at Washington University concludes that “with a little planning we should be able to exploit our mammalian sophistication to develop potent antiparasitic drugs.”

Source: Science, April 2002

Smart Material can both detect and eliminate water pollutants

Removing toxic pollutants from water typically require a number of steps. The aberrant molecules must first be identified, then destroyed or extracted. Finally the water is tested to ensure its purity. According to a report published in *Journal of Physical Chemistry,* a single smart material could execute all the three stages.

Previous research had shown that the compound titanium dioxide had pollution fighting potential. Prasant Kamat and colleagues at University of Notre Dame thus set out to investigate whether a similar compound zinc oxide(ZnO) could degrade organic contamination in water. They tested the material against a class of organic pollutants known as chlorinated phenols. Typically, ZnO emits visible radiation. However, when the material was exposed to water contaminated with a type of chlorinated phenol, the amount of light emitted dropped drastically. The researchers further found that this response was measurable for pollutant concentrations as low as one part per million.

Moreover once the ZnO detected the offending organic molecules, it can also help eliminate them. When exposed to UV light, ZnO aids in the breakdown of the contaminants without being destroyed itself. After the pollutants have been converted into harmless byproducts, the ZnO film begins to glow more brightly. Though commercial applications are not yet available the researchers suggest that ZnO film based nanosensors should be useful in application such as checking the quality of drinking water.

Source: Scientific American Feb 2002

ISRO to launch dedicated health satellite

Indian Space Research Organisation will launch a dedicated health satellite committed to enable health service and telemedicine networking, to reach them to the remotest parts of the country.

This would be the first satellite in the world totally committed to telemedicine and health services, ISRO Chairman, Dr. K. Kasturirangan, said while addressing the Karnataka Telemedicine project. He said the health satellite would have 12 to 14 transponders dedicated to enhance the telemedicine network. Dr. Kasturirangan said that the present telemedicine network’s performance would be studied over the next six months.

The inputs of this study would be used to define a system of designing the satellite and knowing its requirements. The following two years would be spent in evaluating the defined satellite system before a final decision to launch the satellite was taken, Kasturirangan said.

He said it would take three and half years after the final decision was taken to develop and launch the satellite.

ISRO has played a vital role in four telemedicine projects in India. Under these projects, the remote and distant health centres are linked via INSAT Satellite with super speciality hospitals in major towns and cities.

Source : PTI News, April 2002

Compiled by : Kapil Tripathi

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Contd ..... from page 36

Director, Dr. R. Sreedher. Editing of the audio cassettes, conversion of CD-ROM and embellishment with visuals was carried out by Shri V. Krishnamurthy, for which VP is thankful to him.

VP has chalked out its strategies to utilise the powerful technology of satellite radio communication for science and technology popularisation and for education and management of natural disasters, alongwith other established technologies. VP hopes to start regular broadcast on WorldSpace Radio in near future.

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A section of the audience in one of the schools in Delhi where WorldSpace Radio Demonstration-cum-experimental broadcast was organized

Bluetooth

❒ Kinkini Dasgupta Misra

Well, it is not all about bad teeth, as you might imagine but Bluetooth is the name of a new technology, set to commercially come out in bulk with promises to change significantly the way we use machines.

Bluetooth in its most basic from is cable replacement technology. You have your keyboard connected to the computer as well as a printer, mouse, monitor and so on, all these are connected by cables. Bluetooth technology will replace the cables and a Bluetooth connection will provide high speed, low power microwave wireless communication and networking between PCs, mobile phones and other devices. This will enable untethered, wireless connectivity to the Internet, anywhere. It is an open standard for speech and data transmission. Bluetooth is based on a global radio frequency (RF) technology which operates on the 2.4 GHz Industrial, Scientific and Medical (ISM) band.

The Bluetooth wireless technology has evolved from basic cellular digital radio designs implemented in mobile phones since early 1980s. Conceived initially by L.M. Ericsson, before being adopted by a myriad of other companies, Bluetooth is a standard for a small, microchip with radio transceivers to be plugged into computers, printers, mobile phones, etc. Say, for example, when you are on the road and want to access the Internet, Bluetooth will establish the connection between Bluetooth enabled handheld and mobile phone wirelessly, so that you can browse the web and check your emails. Your mobile phone can even automatically dial any number from your handheld address book.

Do you know, where did it get the name from? It is named after a Danish Viking king, Harald Blatand (Bluetooth in English), who lived in the latter part of the 10^{th} century. Harald Blatand united and controlled Denmark and Norway (hence the inspiration on the name: uniting devices through Bluetooth). In the beginning, the goal of Bluetooth wireless technology was the unification of the telecom and computing industries. Since then, the Bluetooth wireless technology has grown to influence nearly all areas where cable replacement is needed.

The Bluetooth SIG (Special Interest Group) is an industry group, comprised leaders in the telecommunications and computing industries that driving developing of technology and bringing to the market. Over 2000 companies have executed the Bluetooth adapter's agreement and are members of the Bluetooth SIG.

Bluetooth borrows radio specifications to enable file-sharing and data transfers between devices like a mobile phone and a desktop. It is an omni-directional and has a present nominal range of 10cm to 10m, which can be extended to 100m with increased transmitting power. The technology achieves its goal by embedding tiny, inexpensive, short-range transceivers into the electronic devices that are available today. Bluetooth operates on a globally available low radio frequency, at 2.4 GHz on ISM band, and supports data speeds of up to 721 Kbps, as well as three voice channels. Although the low frequency is unlicensed (which increases interference from other radio frequencies), Bluetooth SIG says that the technology is designed to be fully functional even in a very noisy radio environment, and its voice transmission can be heard even under severe conditions. The original Bluetooth specification calls for output power of less than 10 milliwatts.

The Bluetooth modules can be either built into electronic devices or used as an adapter. For instance in a PC they can be built in as a PC card or externally attached via the USB port. Each device has a unique 48-bit address from the IEEE 802 standard. Connections can be point to point or multipoint. Bluetooth devices are protected from radio interference by changing their frequencies arbitrarily upto a maximum of 1600 times a second, a technique known as frequency hopping. The Bluetooth radio uses a fast acknowledgment and frequency hopping scheme to make the link robust. Bluetooth radio modules avoid interference from other signals by hopping to a new frequency after transmitting or receiving a packet. Bluetooth module will not interfere or cause harm to public and private telecommunication network.

When one Bluetooth device comes within range of another (this can be set to between 10cm and 100cm) they automatically exchange address and capability details. They can then establish a 1megabits link (upto 2 Mbps in the second generation of the technology) with security and error correction, to use as required.

Let us take a look at how the Bluetooth frequency hopping and personal-area network keep systems work in a typical modern living room. For example, in a room there is an entertainment system with a stereo, a DVD player, a satellite TV receiver and a television; there is also a cordless telephone and a personal computer. Each of these systems uses Bluetooth, and each forms its own network to talk between main unit and peripheral.

The cordless telephone has one Bluetooth transmitter in the base and another in the handset. The manufacturer has programmed each unit with an address that falls into a range of addresses it has established for a particular type of device. When the base is first turned on, it sends radio signals asking for a response from any units with an address in a particular range. Since the handset has an address in the range, it responds, and a tiny network is formed. Now, even if one of these devices should receive a signal from another system, it will ignore it since it is not from within the network. The computer and entertainment system go through similar routines, establishing networks among addresses in ranges established by manufacturers. Once the networks are established, the systems begin talking among themselves. Each network hops randomly through the available frequencies, so all of the networks are completely separated from one another.

Now the living room has three separate networks established, each one made up of devices that know the address of transmitters it should listen to and the address of receivers it should talk to. Since each network is changing the frequency of its operation thousands of times a second, it's unlikely that any two networks will be on the same frequency at the same time. If it turns out that they are, then the resulting confusion will only cover a tiny fraction of a second, and software designed to correct for such errors weeds out the confusing information and gets on with the network's business.

The Bluetooth wireless technology will enable users to connect a wide range of computing and telecommunications devices easily and quickly, without the need for cables. It will expand communications capabilities for computers, mobile phones and other mobile devices, both in and out of the office. But beyond untethering devices by replacing the cables, Bluetooth radio technology provides a universal bridge to existing data networks, a peripheral interface, and a mechanism to form small private ad hoc groupings of connected devices away from fixed network infrastructures.

For further reading:

Bluetooth Application Developer's Guide-by Jeniffer Bray et al; Discovering Bluetooth by Michael Miller; http://www.palmos.com, http://www.eg3.com, www//howstuffworks.com.

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Letters to the Editors

'Dream 2047' : Not only the contents are excellent, but also so is the production quality, which many well-intentioned efforts suffer.

V.S. Borkar
Tata Institute of Fundamental Research
Homi Bhabha Road, Colaba, Mumbai-400 005

Many thanks the monthly journal Dream 2047 Jan. 2002 issue. It is indeed a quality issue, rich in its content and grand in its style, explicit in bringing real scientific material to those who have some interest in science. Such an endeavourer is bound to help develop scientific temper in the country! The printing is flawless and the paper quality is smooth. I have enjoyed reading your article on 'Bosons' in reverence to the great son of India and a doyen of science. I have also read with interest Dr. S. Mahanti's article on Sir K.S. Krishnan who taught me B.Sc. Physics at Allahabad University. I consider myself so fortunate to have known him personally. Kindly give my regards to Dr. Mahanti.

Dr. H.L. Nigam
Snehlok, B-332 B, Sector-A,
Sitapur Road Scheme, Lucknow-226021

I had been following dream 2047 very closely and it became one of the most enlightening and enjoyable monthly reading fare. I especially enjoyed reading the Biographies, the history of Science Institution etc.

Dr. J. Rudra
8/17 Cornfield Road, Ballygunge, Kolkata-700 019

I have received "Dream 2047" and thank you very much for the same. I have been following the activites of Vigyan Prasar ever since it started and I appreciate the efforts taken by you and your colleagues in science popularisation. Please accept my appreciation for your sincere and laudable efforts in bringing out Dream 2047.

Prof. V. Krishnan
INSA, Bahadur Shah Zafar Marg, New Delhi-110002

"Dream 2047" news letter is highly informative in science. I humbly feel that reading such a news letter will be very helpful in improving knowledge in science and knowing the latest developments in science and technology.

J. Bharathidasan
34, T.E.L.C. Compound, 4th cross street.
Anna Nagar, Chengalpattu, P.O. 603001, Tamil Nadu

Your Dream 2047 of Feb. 2002 is wonderful, full of interesting and stimulation information about Sir C.V. All students of science should know how Sir C.V. thought, worked and accomplished so much under such circumstances. Your Monthly Newsletter of Vigyan Prasar is a very useful venture. I enjoy reading it. Please keep it up.

Prof. M.S. Kanungo
Banaras Hindu University, Varanasi-221005

First of all I must congratulate to Dream 2047 team for Winning II Prize in Excellence in publishing. Feb. 2002 Dream edition was good collection for me. I request you to publish the Photos (Blow-up) of famous scientists every month. It will be very useful to collect and also helpful to teachers as teaching material.

Sukumar
Chitradurga, Karnatak

I just received the December issue of Dream 2047. It is an excellent production and contains valuable contributions.

Dr. Swapan K. Ghosh
Theoretical Chemistry Section, Chemistry Division,
Bhabha Atomic Research Centre, Bombay 400 085, India

I have enjoyed reading some issues of Dream 2047 and have shared them with some others. The quality of the articles is excellent; the other features are also interesting. The printing and the paper also contribute to the readability of the newsletter.

Prof. S.C. Dutta Ray
Dept. of Electrical Engineering, Indian Institute
of Technology, Hauz Khas, New Delhi-110016, India

I have received both the Hindi & English versions of Dream 2047. I find the journal most interesting as well as informative. Congratulations on your effort.

B. Ramamurthi
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I find the bilingual Newsletter "Dream 2047" very interesting and request you to continue sending it to me regularly.

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Nuclear Science and its usage

❒ Amit Ray*

Study of nuclear physics or nuclear sciences in general has in its root, the quest of human beings for knowledge of the ultimate origin of the Universe. Just as we would like to know our origins as human beings, trace the evolution of societies or development of the human psyche, so would we like to know the fundamental particles, which make us and the world around us.

There are two facets of the study of nuclear physics. First is the probing of the basic aspects of the science and the second is the technology. Societal support to a branch of science largely depends on the technological fallouts of the study of that science and nuclear science is no exception to that. In fact, large scale governmental support to the sciences started with the realisation that the energy released through the splitting of the atomic nucleus could be harnessed for energy generation as well as for military purposes. And nuclear technology, like all other technologies invented by human beings, has controversies associated with it. A technology, per se is neither good nor evil, it is how it is being used. A question that puzzles me, is why in every stage of human evolution the cutting edge of technology has been employed for destructive rather than constructive purposes. The celebrated humanist inventor, Buckminster Fuller has termed it efforts towards killingry rather than towards livingry.

First let us consider the current state of our understanding of basic nuclear physics and the constituent of matter. We now know the size and shape of a large number of nuclei, which are at the core of atoms. The nucleus has a very small size, only of the order of 10^{-11} m. If we assume the atom to be of the size of a typical lecture room, the nucleus would be the size of a grain of sand. You have to, of course, blow up the atom ten million times before it would take the size of a grain of sand. All nuclei are not spherical, they come in the sizes of oranges, pear, cigars, etc. You may wonder why should anyone bother about how these tiny insignificant specks of material look like. These details give us vital clues to what holds the nucleus together and how. If we probe further, the nucleus also is a conglomerate of tinier particles named proton and neutron. Their sizes have also been determined rather accurately and they are roughly one-tenth the size of the nuclei. Going to further sub-microscopic levels, we find that the protons and neutrons are also composed of other particles called quarks. Quarks have not been observed in a free state nor their sizes have yet been accurately determined. Obviously, they have to be smaller than either a proton or neutron. The other constituent of the atom, the electron has a size smaller than 10^{-14} m. The current thrust of research is to understand how all these tiny particles of matter interact among themselves and how exactly are they arranged to give us the myriad arrangements of objects we see around us.

Another fundamental area of study in the nuclear sciences is the origin of elements in the universe. All materials including us, are constituted from atoms made in some star or other celestial objects through the process of nuclear reactions. Understanding of the nuclear processes in the laboratories using giant machines called particle accelerators has given us a rough understanding how a majority of the elements have been formed. There are still lots of details missing and that provides the impetus to current research. The basic tools with which we study nuclear physics are the accelerators, the detectors and the electronic and computer systems for data acquisition and analysis. The push for understanding nuclei and its constituents have resulted in improvements in all the three above mentioned tools and made them available to other fields of study.

Thus nuclear science provides very powerful tools for studies in many other areas like material science, biology, chemistry, geology, archaeology, forensic science, etc. In condensed matter and materials science, structure of materials can be determined using neutron diffraction and Extended X-ray Auger Fluorescence Spectroscopy (EXAFS) using synchrotron radiation. Nuclear magnetic resonance provides a very versatile tool for this field. The composition of materials can be obtained through a host of techniques like Proton Induced X ray Emission (PIXE), Elastic Recoil Detection Analysis (ERDA), Rutherford Backscattering (RBS), Secondary Ion Mass Spectrometry (SIMS), etc which are all offshoots of nuclear studies. Recently swift heavy ions are being used for material modifications and creating novel materials.

Synchrotron radiation, being a very powerful source of photons, is being used extensively in determining structures of molecules of interest to chemistry and biology. The technique of Accelerator Mass Spectrometry (AMS) is used in a number of areas of study, e.g., geology, oceanography, archeology and climate studies. In AMS, atoms from a minute sample are ionized and accelerated to a sufficient high energy that one can detect and identify individual atoms, using nuclear detection techniques. It has a very large sensitivity and requires very small quantities of the tracer material. In Biological applications of AMS, one can determine the uptake of chemicals through the skin or measure the damage to DNA by carcinogens or mutagens at actual exposure levels. For example, the amount of benzene from a single cigarette has been traced in vivo to the exact proteins in the bone marrow of a mouse that this toxin affects.

There are direct industrial applications of nuclear science in many fields, a few of which are mentioned below.

Ion implantation for semiconductors is used for fabrication of accurate and reproducible microcircuits. Other use of ion beams has been in improving surface hardness of metals, coatings, corrosion resistance, changing the coefficient of friction, adhesive properties. Ion implanted materials find applications in automotive and aviation industries (ball bearings, crankshafts, rotor shafts) and in medical field (artificial hip and knee joints).

Radiation processing is used for making of plastics, which are insoluble in organic solvents, fire resistant and capable of operating under adverse environments. Varnishes and paints can be cured very fast. It is also useful for destruction of noxious materials and for purification of industrial gases.

Food preservation and sterilisation of materials for industrial and medical use is another area where radiation produced by electron accelerators is being widely used. Irradiated food can be stored for long periods at room temperature without deterioration. This method avoids use of toxic chemicals, traces of which may remain in the foodstuffs.

Formation of micro-filters, which are being used as filters in the food industry, for separation of components of blood plasma, and as porous substrates for growing cells or micro-organisms in biological research.

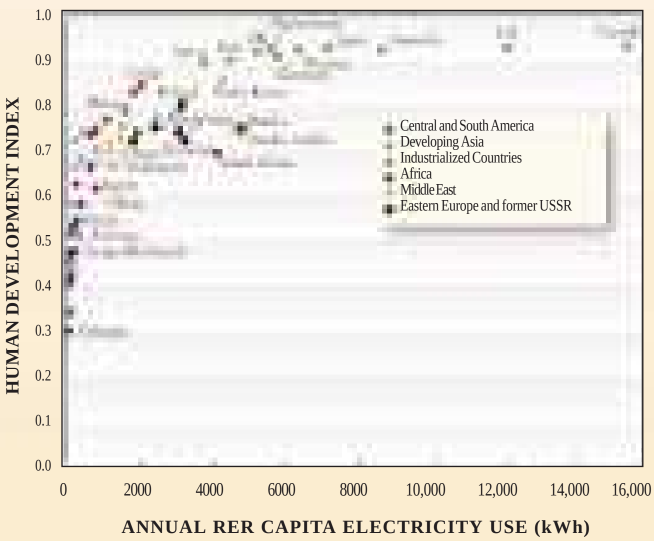
Medicine and therapy benefit from the use of radioisotopes and use of high-energy rays for treatment of cancer. Vast majority of the radiation therapy facilities uses either gamma rays from cobalt-60 or the x-rays from an electron linac. Accelerated charged particles or secondary neutrons produced by accelerators are also being used for cancer therapy with deeper and controlled penetration in the body tissues. Accelerator produced positron emitters are being used in positron emission tomography (PET). Superconducting magnet technology that grew out of the accelerator development has found a fast-growing field of magnetic resonance imaging (MRI).

Nuclear Energy and Nuclear Waste Management

I would like to address a problem, which desperately needs a solution and the need is indeed very urgent. The problem is how to provide for the growing demand of energy needed by our country. Consumption of energy is an indicator of the standard of living of the population of a country and for most Indians it is abysmally low. The United Nations compiles annual statistics about human development and the environment in 174 countries. The statistics relate to energy use, life expectancy, nutrition and health, income and poverty, education, CO2 emissions, and so on. Three of the indicators are combined to calculate a Human Development Index (HDI). Those indicators are: longevity, as measured by life expectancy; educational attainment, as measured by a combination of adult literacy (two-thirds weight) and the combined primary, secondary, and tertiary enrollment ratio (one-third weight); and standard of living, as measured by a discounted gross domestic product (GDP) per capita. The UN's HDI is considered by many to be a fair measure of basic human well-being.

Alan Pasternak of Lawrence Livermore National Laboratory recently looked at energy usage in the 60 most populous countries for which the UN had an HDI; those nations contain 90% of Earth's population. This is shown in the next figure.

(Ref: A. Pasternak, Global Energy Futures and Human Development: A Framework for Analysis, Lawrence Livermore National Laboratory rep. no. UCRL-ID-140773 (October 2000).



He found a correlation between electricity consumption and the HDI. His analysis showed that the HDI reached a high plateau when a nation's people consumed about 4000 kWh of electricity annually per capita, a value unchanged between 1980 and 1997 data. The correlation is not perfect; in the end, each country's situation is unique. Still, Pasternak concludes that reaching the goal of basic human well-being in poor countries will require "significantly greater global consumption of electricity and primary energy than do projections for 2020 by the DOE and others." If the world agrees to that goal, working to solve the energy challenge is even more imperative.

For India, the consumption of electrical power is only ~400 kWh, about one-tenth that required to catch up with the developed world. Similar situations exist for most of the developing nations. Developing nations will therefore need about 5 x 106 MW of new electricity-generating capacity in the coming decades, compared with the 1 x 106 MW they have today and the 2 x 106 MW in the industrial nations. (Electricity generation accounts for only about one-fifth of our final energy consumption - the rest mainly being for transport and heating.)

Finding ways of satisfying our energy needs is such an urgent problem that we must consider all possible sources, and evaluate them as objectively as possible. In doing so, it is useful to apply the following criteria: capacity, cost, safety, reliability and environmental effects. No source can satisfy all our energy needs, and although there are several small-scale energy sources, such as solar panels for satellites, we must focus on the major sources.

Historically energy has been produced on earth by chemical reactions- such as burning of coal, wood, gas and petroleum products. Animals get their source of energy by utilisation of food in their bodies. However, it was realised long ago that chemical reactions could not be the source of energy radiated by stars such as our Sun. If the Sun was made of entirely coal and oxygen, it could not produce energy at the present rate for more than about a thousand years, whereas we know that it has done so for about 5 billion years. The only other reactions that produce energy are the nuclear reactions, which produce typically a million times more energy than chemical reactions. Thus it appeared that nuclear reactions must be responsible for energy production in stars. This is the fusion reaction, where hydrogen is converted into helium producing energy. This is going on in our Sun. On the earth, so far man has not succeeded in using this reaction in a controlled way to utilise the energy produced. The reaction has been realised in the hydrogen bomb. However, there exist another nuclear reaction, the fission reaction, in which a large nucleus like uranium splits into smaller nuclei and neutrons and energy is released. This reaction has been used in controlled way in nuclear reactors, which can supply energy to our homes. It has also been exploited in making the so called atom bomb.

A comparison of the energy release in the processes are:

In fusion -- 80 billion kilocalories per kilogram. And in fission -- 19 billion kilocalories per kilogram, whereas in coal burning -- 7200 kilocalories per kilogram.

The advantages of nuclear energy are:

1. The energy produced for amount of material consumed is highest of all fuels.
2. Costs are competitive with coal, the major source in the world.
3. Uranium, the source material, is abundant.
4. Plutonium, a by-product of commercial power plants, can also be used as a fuel.
5. The amount of waste produced is the least of any major energy production process. It does not discharge into the air carbon dioxide or pollutants such as nitrogen oxides and smog causing sulphur compounds.
6. Nuclear energy provides benefits other than electricity generation. Radioactive materials, produced in reactors, are used in medicine, radiography, space applications, food irradiation, etc.

The main problem of nuclear energy is the highly radioactive waste produced, some of which remain active for very long periods of time (several thousands of years). So this waste has to be kept under strict control for that long periods of time. Scientists all over the world are working on how to solve this problem.

Problems:

? Highly radioactive waste is produced, some of which remain active for very lon periods of time.

? Long-term storage and disposal of these wastes remains an unsettled issue.

The waste products produced in a commercial reactor are shown in the following table.

Major Long-lived (t1/2 > 10 yr) radioactive products in a 1000 MWe light water reactor spent fuel 10 years after removal from core

NUCLIDE	HALF-LIFE(y)	%
Actinides		
237Np	2100 000	4.5
238Pu	80	1.4
239Pu	24 000	51.4
240Pu	6600	23.8
241Pu	14	7.9
242Pu	380 000	4.8
241Am	430	5.1
243Am	7400	0.9
244Cm	18	0.2
Fission Products		
79Se	65 000	0.2
85Kr	11	0.3
90Sr	29	11.4
93Zr	1500 000	19.7
99Tc	210 000	21.0
107Pd	6500 000	6.2
126Sn	100 000	0.9
129I	17 000 000	4.9
135Cs	3 000 000	8.0
137Cs	30	27.0
151Sm	90	0.3

So far the strategy for storage and waste management has been to concentrate these wastes either in a liquid form or in the form of vitrified solids and store them in a protected environment like that of a salt mine. The repository must be in a geologically inactive area so that the possibility of movement of the wastes in the time scales of million years is remote. There is also potential proliferation questions that arise from the long-term storage. The scientific uncertainty in this process generates legitimate public concern and political pressures which have been responsible for the slowing down of nuclear energy generation in the western countries. However, if you carefully note the growth of energy consumption in the developed countries has itself slowed down since it is very near saturation.

Presently there are about 438 reactors operating

Energy data

Renewable energy potential and achievements in India

[TERI Energy Data Directory & Yearbook 2001/2002]

Sources/technologies	Units	Approximate potential	Achievements (till December 2000)
Wind Power	MW	45,000	1,267
Small hydro power (upto 25 MW)	MW	15,000	1,341
Biomass power	MW	19,500	308
Biomass gasifiers		16,000	35
Biomass cogeneration		3,500	273
Urban and Industrial waste based power	MW	1,700	15.20
Solar photovoltaics	MW/km2	20	47 (MW)
Solar water heating	million m2 collector area)	140	0.55
Biogas plants	million	12	3.10
Improved biomass chulhas (cookstoves)	million	120	33.00

Source: MNES. 2001. New Delhi: Ministry of Non-conventional Energy Sources.

Nuclear Power in INDIA

Total Nuclear Power Generation Capacity: 2720 MWe

India's Nuclear Power Programme has fourteen operating reactors including 2 Boiling Water Reactors (BWR) and 12 Pressurised Heavy Water Reactors (PHWR). It has at present two PHWRs under construction of 500 MWe capacity each at Tarapur in Maharashtra. Nuclear Power Corporation Ltd. (NPCIL) is the public sector company which owns, constructs and operates nuclear power plants in India. NPCIL which is spearheading the nuclear power programme in India plans to put up a total installed nuclear power capacity of 20,000 MWe by the year 2020.

Operating Nuclear Power Reactors

Location	Type/Capacity
Tarapur	BWR/2x160 MWe
Rajasthan	PHWR/1x100, 1x200 MWe and 2 X 220 Mwe
Kalpakkam	PHWR/2x170 MWe
Narora	PHWR/2x220 MWe
Kakrapara	PHWR/2x220 MWe
Kaiga2	PHWR units of 220 MWe

Reactors Under Construction

Location	Type/Capacity	Expected Criticality Date
Tarapur	PHWR/2x500 MWe	oUNIT 3- July 2006 oUNIT 4- October 2005

Source: Department of Atomic Energy, Government of India.
Website: www.dae.gov.in

worldwide producing about 16% of the world's electricity. In India we have at present 14 reactors working producing 2720 MW of power. From the type of growth projected we see that a sizeable fraction of global electricity generation is going to be from nuclear power.

Recently there have been some developments in the field of accelerators which give a lot of hope in solving the vexing problem of radioactive waste management. It may indeed be possible to practically eliminate all radioactive wastes and not only that, but also generate some additional power in the bargain. The idea has been named Accelerator Driven Sub-critical systems (ADS).

The ADS concept is that of a sub-critical reactor, where the neutron multiplication takes place through fission with a steady supply of accelerator produced neutrons. There is no possibility of a self-sustained chain reaction with infinite neutron multiplication. Fluxes as high as 1016 n /cm^2/s can be achieved in the blanket volume with multiplication factor of 10, i.e., a criticality of 0.9. When the accelerator drive stops, the reactions die off exponentially in a few seconds, making it immune from uncontrolled runaway reactions. Another advantage of the sub-critical system is that it can work with different fuel mix like ^{228}Th or ^{233}U. Further research and development is required towards achieving the required beam power without beam losses. The accelerator reliability has to be >95% and the cost of the machine has to be low enough.

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