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VP News

Inside

Science Radio Serials in Chhattisgarh

As part of the ongoing activity of Vigyan Prasar in popularizing science using the medium of radio, a two-day workshop was organized at Raipur during 25-26 April 2005, to deliberate and brainstorm on the possible themes and topics to be taken up in the proposed radio serials-one in Chattisgarhi and one in Gondi, a tribal language. In fact as regards Gondi, spoken in Bastar region of Chattisgarh, this would be the first ever science radio serial.

Chattisgargh is rich in minerals and hence is called the 'museum of minerals'. In fact about 28 minerals are found in the state and tin is exclusively extracted from this state in India. With varied geographical terrain, people and culture, the theme 'Wealth of Chattisgargh' was identified as the suitable and desirable theme for the programme in Chattisgarhi by the experts assembled.

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International Astronomy Week

As part of the International Astronomy Week activities, Vigyan Prasar organized a number of events in New Delhi from 11 to 17 April 2005 and arranged the experiment for ' Measurement of Diameter of Earth' in association with National Science Center (NSC), New Delhi.

VP conducted an Astronomy quiz and essay competition in four schools of New Delhi viz. Swami S. M. Sec. School, East Panjabi Bagh; S.B. Mills Sr. Sec. School, Shivaji Marg; Sarvodaya Vidyalaya, Jaidev Park; and DTEA School, Lodhi Estate. Astronomy Kit, Hello Stars book and World Year Physics (WYP) booklets on Einstein and his work (brought out by VP) were given away as prizes to the winners of these competitions.

As a unique event, VP in association with National Science Center (NSC) and with cooperation from Dr. Gholamhossein Rastagar Nasab from Rey City, Iran, measured the diameter of Earth as a students' project. The programme was organized on 14 April 2005

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Students measuring the shadow length of gnomon, at National Science Centre, New Delhi

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

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Editor : Dr. V.B. Kamble

Bridging the Divide

The Satellite Instructional Television Experiment in the mid-1970s was probably the biggest social experiment anywhere in the world that established the importance of satellite communication in the field of education in India. The widespread use of personal computers since nearly two decades ago, advances in telecommunication, Internet a decade ago, and mobile phones along with convergence of various technologies has, in the form of Information and Communication Technology (ICT), opened up new opportunities and challenges in the field of education. Indeed, the impact of Information Technology (IT) industry on the economy has been enormous. During the last year alone, IT contributed 3 per cent of India's gross domestic product (GDP).

However, the vast potential of ICT in the field of education remains largely untapped. The efforts have been piecemeal and sporadic. A beginning for introducing computers in the school system was made through the Computer Literacy and Studies in Schools (CLASS) project in the early 1980s. However, schools faced problems of infrastructure, appropriate software and lack of trained manpower. Today, the scenario has changed with large number of cyber cafes, increasing use of personal computers in schools, homes and workplaces, and internet connectivity. No doubt, ICT holds renewed promise as a powerful tool for education and development. The debate on the digital divide, however, continues unabated. Why is that? Is it that ICT has benefited haves rather than have-nots? Is digital divide a problem in itself?

Indeed, the digital divide signifies more deep rooted divides of income, development and literacy. This is especially true of developing countries. There is no gainsaying the fact that fewer people in developing countries like India own computers and have access to the internet. The reasons are many – they are too poor, illiterate or have more pressing concerns like food, healthcare and security. A computer is of little use if there is no food or electricity or if one cannot read. True, there have been a few sporadic attempts to set up centres with the aid of international donor agencies and local government support to offer villagers a range of information including market prices for crop, job listings, welfare schemes of government, healthcare, etc. However, due to the more basic problems outlined above, a large section of population has remained deprived of the ICT boom in the country. Surely, centres like the M.S. Swaminathan Research Foundation in Nagpattinam have been providing information on sea wave heights, weather patterns and satellite mapping for the movements of large schools of fish in the ocean. But, it is imperative to ensure that this information does not benefit the rich alone. Conscious efforts need to be put in so that even the poor fishermen lacking motorboats and navigation equipment are also equally benefited.

How do we make rural ICTs particularly useful to the illiterate and the poor who are at the bottom of the socio-economic ladder? An important factor – rather a deciding factor in determining whether the digital divide can ever be bridged is the cost of the technology. It is, therefore, imperative that we develop appropriate low-cost technologies that can drastically cut the cost of access to information – even if such innovations do take time and require high investment to begin with. At the same time, we cannot afford to turn Nelson's eye to the older technologies and the proven means of delivery systems like the community radio, used by several development organizations. Simple technologies like receiving information from loudspeakers or a newsletter printed and delivered around a village could form an integral part of an internet hub located in a village. Such hybrid networks may well prove to be the appropriate technologies for a country like India and the other developing countries.

A technology which has made a significant mark with regard to the information access is that of mobile phones, which do not rely on a permanent electricity supply and can be used by people who cannot read or write. In particular, the widespread use of mobile phones among the women of Bangladeshi villages, the telephone ladies, is well known. Farmers and fishermen of India have been using mobile phones to call market and work out where they can get the best prices for the produce. Small businessmen use them to shop around for supplies and even for making cashless payments. If we could make the mobile network accessible to our rural folk, we may be in a position to bridge the digital divide to a great extent, rather than trying to close the digital divide through top down IT infrastructure projects.

EduSat provides an interactive satellite-based distance education system for the country utilizing audiovisual medium, and employing Direct-To-Home (DTH) quality broadcast. With its multiple regional beams covering different parts of India and a beam covering the Indian mainland, it is possible to establish talk-back terminals for interactive programmes on science education. These

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Louis de Broglie

Discoverer of the Wave Nature of Particles

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> "Having much more the state of mind of a pure theoretician than that of an experimenter or engineer, loving especially the general and philosophical view, I was drawn towards the problems of atomic physics…It was the conceptual difficulties which these problems raised; it was the mystery which surrounded that famous Planck's constant, h, which measures the quantum of action; it was the disturbing and badly-defined character of the dualism of waves and corpuscles, which appeared to assert itself more and more in the realms of physics…"
>
> ***Louis de Broglie***

Prince Louis-Victor-Pierre-Raymont, 7th duc de Broglie, generally known as Louis de Broglie, is best known for his research on quantum theory and for his discovery of wave nature of electrons. He was awarded the 1929 Nobel Prize for Physics "for his discovery of the wave nature of electrons." The wave-like behaviour of particles discovered by de Broglie, was used by Erwin Schrodinger in his formulation of wave mechanics.

Louis de Broglie

Louis de Broglie was born in Dieppe (Seine-Maritime), France on August 15, 1892. He was the younger son of Victor, 5th duc de Broglie. His mother was Pauline d'Armaille.The de Broglie family is one of the most illustrious families of France. De Broglies came to serve the French kings in the seventeenth century. The family came from Piedmont, then in France and now in Italy. In 1740 Louis XIV had conferred on the head of the family the hereditary title of duc (duke). The German title Prinz (Prince) dated in the family from service to the Austrians during Seven Years War (1756-63). The de Broglies achieved high distinctions as politicians, diplomats and soldiers. Four members of de Broglies became Marshals of France. The French Revolution was a difficult and trying time for de Broglie family and at least one de Broglie died at the guillotine. The family remained prominent in French public life throughout the nineteenth century.

De Broglie was exceptionally charming in his childhood. His elder sister wrote: "This little brother had become a charming child, slender, svelte, with small laughing face, eyes full of mischief, curled like a poodle. Admitted to the great table, he wore in the evenings a costume of blue velvet, with breeches, black stockings and shoes with buckles, which made him look like a little prince in a fairy tale. His gaiety filled the house. He talked all the time even at the dinner table where the most severe injunctions of silence could not make him hold his tongue, so irresistible were his remarks. Raised in relative loneliness he had read much and lived in the unreal….he had a prodigious memory and knew by heart entire scenes from the classical theatre that he recited with inexhaustible verve….he seemed to have a particular taste for history, in particular political history….hearing our parents discuss politics he improvised speeches inspired by the accounts in the newspapers and could recite unerringly complete lists of ministers of the Third Republic, which changed so often…a great future as a statesman was predicted for Louis."

De Broglie was educated at home by private tutors. In 1906, his father died. His elder brother Maurice, then at 31, took charge of his upbringing. It was at Maurice's advice he was sent to Lycee Janson de Sailly, where he spent three years before completing his secondary school education in 1909. Maurice wrote: "Having experienced myself the inconvenience of a pressure exercised on the studies of a young man I refrained from imparting a rigid direction to the studies of my brother, although at times his vacillation gave me some concern. He was good at French, history, physics, philosophy, indifferent in mathematics, chemistry and geography, poor in drawing and foreign language."

On completion of school education, de Broglie joined the University of Sorbonne. At the time of joining the university, he had no definite plan for a career. He was not attracted to the idea of a military or diplomatic career. At the beginning he studied history but he did not like the uncritical way the history was taught those days. From history he shifted to law with a view to make a career in the civil service. At the age of 18 he graduated with an arts degree. He was then assigned a research topic in history of his choice. But he did not complete his research in history. Instead he decided to study theoretical physics, a subject he chose to devote his life to. In deciding to study physics he was greatly influenced by Poincare's masterworks, *La valeur de la science and La science et* *l'hypothese.* In choosing theoretical physics as a career, he was also influenced by his elder brother Maurice, who was also a physicist and made notable contributions to the experimental study of the atomic nucleus. Maurice kept a well-equipped laboratory at the family mansion in Paris. However, his journey in theoretical physics was not very smooth. In those days at the Sorbonne University the teaching of physics did not include the recent developments in the subject like Maxwell's electromagnetic theory or statistical thermodynamics. The course was based on standard subject like mechanics and wave optics. Books on these topics were also not available in French. French translations of foreign textbooks were often of poor quality. De Broglie made it a point to attend Poincare's lectures on electrodynamics, thermodynamics, celestial mechanics and other subjects. In his initial years he passed through emotional and psychological problems. Apparently this was triggered by the marriage of his elder sister Princess Pauline, to him he was deeply attached. Princess Pauline was 20 years older than de Broglie. After her marriage de Broglie lost her youthful personality full of gaiety and spirits. He lost an examination in general physics. Following these developments when his self-confidence at its lowest, he chanced upon reading the report of the first Solvay Conference on quantum theory. At the end of reading this report in depth he was confident that theoretical physics would be his career. In 1913 de Broglie obtained a science degree.

Maurice de Broglie

After attaining the required age, he had to join the military service as it was mandatory for everyone in France. He had to stay in army for six years as the First World War broke out. Initially he was sent to the fort at Mont Valerien, where he had nothing much to do and it was a very difficult situation for him. However, his brother exerting his influences got him transferred to the radiotelegraphy section situated at the bottom of the Eiffel Tower, on which a radio transmitter had been installed. De Broglie served as telegraph operator. Commenting on his war-time work de Broglie later commented that he "was able to serve his country while working as an electrician, taking care of machines and wireless transmissions and perfecting heterodyne amplifiers then in their infancy." De Broglie later admitted that the practical experience gained during the war time helped him in his scientific research. After the war was over, de Broglie resumed his studies of physics with his elder brother, Maurice, who worked on experimental physics in his well-equipped laboratory in the family mansion in Paris. Unlike his brother, de Broglie was interested in the theoretical aspect of physics. Immediately after he was decommissioned from the army, he attended a seminar given by Langevin on quantum theory and then a course on relativity. De Broglie wrote: "...demobilized in 1919 I returned to the studies I had given up, while following closely the work pursued by my brother in his private laboratory with his young collaborators on X-ray spectra and on the photoelectric effect. Thus I made my first steps towards research by publishing a few results in the fields studied by my brother.

In a first series of publications I considered the adsorption of X-rays, its interpretation by the theory of Bohr, and its relation with thermodynamic equilibrium...some of the reasonings I used were questionable but they led me to formulae which gave an acceptable account of the facts. At the same time I had long discussions with my brother on reinterpretation of the beautiful experiments that he pursued on the photoelectric effect and corpuscular spectra. I published, with him or separately, a series of notes on the quantum theory of these phenomena which, although classical now, was not well established then."

Eiffel Tower

In 1923 de Broglie brilliantly brought together the concepts of the particle and the wave. He was influenced by Einstein's work on particle nature of light. De Broglie wrote: "After long reflection in solitude and meditation, I suddenly had the idea, during the year 1923, that the discovery made by Einstein in 1905 should be generalized by extending it to all material particles and notably to electrons." At the beginning of the twentieth century physicists explained physical phenomena in terms of particles like electrons or protons and electromagnetic radiation like light, ultraviolet radiation etc. While particles were visualized as discrete entities forming atoms and molecules but electromagnetic radiation were conceived as a wave motion involving changing electric and magnetic fields. This conventional visualization of the physical world was changed by Einstein's work. The special theory of relativity founded by Einstein showed that matter itself was a form of energy. While explaining the photoelectric effect, Einstein proposed that electromagnetic radiation, a wave, can also behave as particle (photon).

De Broglie, influenced by Einstein's work, proposed that just as waves can behave as particles, for instance electrons, can also behave as it were a wave motion (a de Broglie wave) with wavelength h/p, where p is the momentum of the electron and h is Planck's constant. He summed up his discovery in the following words: "Because the photon, which, as everyone knows, is a wave, is also a particle, why should not the electron (or any material particle) also be a wave?" His revolutionary idea was put forward in his doctoral thesis of 1924, entitled *Recherches sur la theorie des quanta (Research on Quantum Theory)*. It contained the idea of matter waves. The thesis was published as a paper of over 100 pages in *Annales der Physique* in 1925. Today it may seem to be very logical to think that way but for de Broglie it was a daring act. This was rightly taken note of by the Nobel Committee. In its citation noted: "When quite young, you threw yourself into the controversy raging over the most profound problem in physics. You had the boldness to assert, without the support of any evidence whatsoever, that matter had not only a corpuscular nature but also a wave nature. Experiments came later and established the correctness of your view."


Clinton Davisson

The idea which later proved to be of far-reaching implications was taken very seriously by many scientists. Ralph Fowler reported de Broglie's discovery to the British scientific journals and Langevin apprised Einstein of the development, who in turn reported it to Berlin Academy of Sciences. These developments ensured rapid spread of the "bizarre" ideas of de Broglie, till then an obscure theoretical physicist and mostly known to the scientific community as "Maurice's younger brother." Einstein was very sympathetic to de Broglie's idea. He wrote to Langevin: "Louis de Broglie's work has greatly impressed me. He has lifted a corner of the great veil. In my work I obtain results which seem to confirm his. If you see him please tell him how much esteem and sympathy I have for him."


Lester Germer

The experimental verification of de Broglie's discovery of wave nature of particles became feasible after Walter Elsasser, a graduate student at the University of Gottingen, suggested that like X-rays, electrons could be diffracted by a crystals. Compared to the spacings between atomic layers in crystal, the wavelengths of de Broglie's waves corresponding to high speed electrons were shorter. Thus for de Broglie's waves, a crystal lattice would serve as a three-dimensional diffraction gratings and sharp peaks in the intensity of the diffracted beams should occur at specific angles. This was actually experimentally verified in 1927 by Clinton Davisson and Lester Germer at the Bell Labs in New York City and by George Paget Thomson at the University of Aberdeen, Scotland.

The fact that particles can behave as waves and radiations (waves) can behave as particles is called wave-particle duality. This has caused intense debate as to the "real" nature of particles and electromagnetic radiations—whether there is determinacy in quantum mechanics. De Broglie himself believed that there is true determinable physical process underlying quantum mechanics and that the current indeterminate approach in terms of probability can be replaced by a more fundamental theory.

After receiving his PhD degree of the Sorbonne University in 1924 de Broglie completed two years' free lectures at the Sorbonne University before he was appointed Professor of Theoretical Physics at the Henri Poincare Institute, which had just been built in Paris with the purpose of teaching and developing theoretical physics. In 1932, he was appointed to the chair of theoretical physics at the Faculty of Sciences of the Sorbonne University, where he taught till 1962. Joan James, in his *Remarkable Physicists: From Galileo to Yukawa,* wrote: "For thirty-three years duc Louis lectured at the Sorbonne. He took a very exalted view of his duties as a teacher, the books that originated from his lectures, beautifully written and carefully produced, brought instruction and enlightenment. In his teaching he took great care when presenting his own ideas to explain that they were not generally accepted. However, as a lecturer in the classroom he was uninspiring. Starting scrupulously on time, he read in his high-pitched voice and in a somewhat monotonous tone from abruptly at the end of the hour and departed immediately. He also ran a well-attended weekly seminar at which young and not so young theorists could expound their ideas." Many students from France and other countries came to work with him and a large umber of PhD theses were prepared under his guidance.

Recalling the origins of his discovery, de Broglie in a lecture delivered in 1945 said: "Thirty years ago, physics was divided into two camps:...physics of matter, based on the concepts of particles and atoms which were supposed to obey the laws of classical Newtonian mechanics, and the physics of radiation, based on the idea of wave propagation in a hypothetical continuous medium, the luminous and electromagnetic ether. But these two systems of physics could not remain detached from each other: they had to be united by the formation of a theory of exchanges of energy between matter and radiation …the intervention of quanta and of Planck's constant h, as much in the theory of photons as in that of the quantization of the electronic movements, seemed to me to show clearly that the link between the two terms of the wave-corpuscle dualism took place through the intermediary of the quantum of action, and must in consequence be expressed mathematically for formulae in which the constant h would appear. This was already the case for the relations which, in the theory of the photon, expressed the energy and momentum of the corpuscle of light as a function of the frequency and of wavelength of the luminous wave, and the form of these relations gave an indication of the interaction that had to be established in the general case of any corpuscle whatever…Thus I arrived at the following general idea which has guided my researches: for matter, just as much as for radiation, in particular light, we must introduce at one and the same time the corpuscle concept and the wave concept. In other words, in both cases we must assume the existence of corpuscle accompanied by waves. But corpuscles and waves cannot be independent, since, according to Bohr, they wre complementary to each other; consequently it must be possible to establish a certain parallelism between the motion of a corpuscle and the propagation of the wave which is associated with it."


Henri Poincare

After his path-breaking discovery de Broglie's work chiefly devoted to various extensions of wave mechanics—Dirac's theory of the electron, the new theory of light, Uhlenbeck's theory of spin, applications of wave mechanics to nuclear physics, etc. Towards the later part of his scientific career de Broglie worked towards developing a causal explanation of wave mechanics, in opposition to the wholly probabilistic models which dominate quantum theory but he had to abandon it in the face of severe criticism of fellow scientists.

It was Louis de Broglie, who in 1949 at the Lausanne European Cultural Conference, issued the first high level call for establishing multinational laboratory as an instrument to revive European research. He was joined by Raoul Dautry, administrator general of the French Atomic Energy Commission; Pierre Augur, Director of UNESCO's Department of Exact and Natural Sciences (1948-1959); and Edoardo Amald, one of the founders of Italy's National Institute for Nuclear Physics. This led to establishment of the European Organisation for Nuclear Research (CERN).

In 1933, de Broglie was elected a member of the French Academy of Sciences. He became a permanent secretary of the Academy at the age of fifty, a post he held till he resigned at the age of 83. But he continued to be associated with the Academy in an honorary capacity till his death. The Academy awarded him its *Henri Poincare Medal* in 1929 and the Albert I of Monaco Prize in 1932. The French National Scientific Research Centre awarded him its gold medal in 1956. Among other awards received by him included Grand Cross of the *Legion d'Honneur of France* and Officer of the *Order of Leopold of Belgium*. He was among the few scientists to be elected to the literary Academy of France. He was elected a foreign associate of the US National Academy of Sciences in Washington and a foreign member of the Royal Society of London. In 1960, upon the death without heir of his elder brother, Maurice, 6th duc de Broglie, Louis de Broglie became the 7th duc de Broglie.

De Broglie published more than 25 books on various subjects of physics. Some of his important publications are: *Waves and Motions* (1926), *Wave Mechanics* (1928), *Non-linear Wave Mechanics: A Causal Interpretation* (1960), *Introduction to the Vigier Theory of Elementary Particles* (1963), and *The Current Interpretation of Wave Mechanics: A Critical Study* (1964). In addition to his strictly scientific work De Broglie wrote on popular aspects of physics, and philosophy of science including the value of modern scientific discoveries. Among his popular books on physics included *Matter and Light: The New Physics* (1939); *The Revolution in Physics* (1953), *Physics and Microphysics* (1960) and *New Perspectives in Physics* (1962). In 1952, de Broglie was awarded the first Kalinga Prize by UNESCO for his efforts to explain modern physics to laymen.

Louis de Broglie died on March 19, 1987 in Louveciennes (Yvelines).

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Hans Albrecht Bethe

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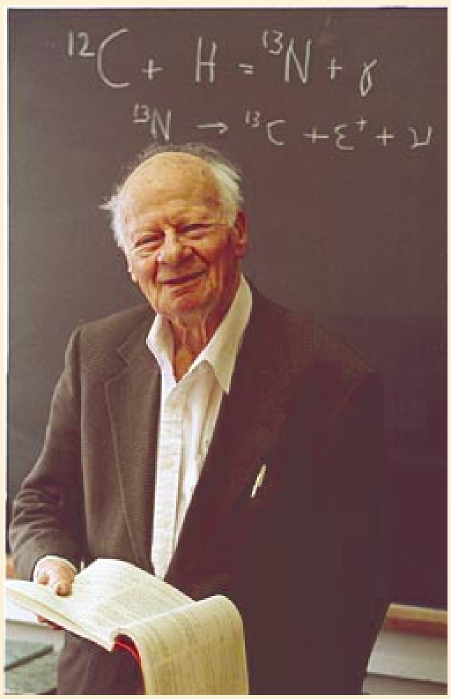
Nobel laureate Hans Albrecht Bethe, German-born American theoretical physicist, who played a key role in designing the first atomic bomb and worked out how stars generate their energy, died in Ithaca, New York, USA on 6 March 2005, at the age of 98. Bethe had been a professor of physics at Cornell University, Ithaca, since 1935. He became a US citizen in 1941.

Bethe was born in Strasbourg, then part of Germany (now in France), on 2 July 1906. He attended the Gymnasium in Frankfurt from 1915 to 1924, and then studied at the University of Frankfurt for two years. He took his PhD in theoretical physics from Munich University with the German physicist Arnold Sommerfeld in July 1928. He fled to England in October 1933 to escape the Nazi regime. After brief spells at the universities of Manchester and Bristol, he moved to the United States, where he taught as a professor at Cornell University. He stayed at Cornell ever since, except for sabbatical leaves and for an absence during World War II. Bethe's arrival at Cornell University launched the Department of Physics into the top rank. It was at Cornell, before World War II, that Bethe published his famous reviews of nuclear physics, and conducted his groundbreaking work on the theory of energy production in stars for which he was awarded the Nobel Prize in 1967.

During the World War II, Bethe worked on microwave radar at the Radiation Laboratory of the Massachusetts Institute of Technology. Then he served as part of a special summer session at the University of California, Berkeley at the invitation of the American physicist Robert Oppenheimer, which outlined the first designs for the atomic bomb. When Oppenheimer started the secret weapons design laboratory, Los Alamos, New Mexico, he appointed Bethe as Director of the Theoretical Physics Division. The Los Alamos laboratory was home to the Manhattan Project, which build the world's first atomic bomb. One of his team's key tasks was to work out the critical mass of uranium-235 necessary to sustain the fission reaction that would drive the bomb's explosive force.

At the end of the War, Bethe worked, along with the Hungarian-born American nuclear physicist Edward Teller, on the development of the hydrogen bomb. At the same time, he became an active proponent of the peaceful exploitation of nuclear energy.



Hans Albrecht Bethe

After the War, he brought some of the most outstanding young physicists from Los Alamos to Cornell, in particular, Richard Feynman and Robert Wilson. Under their leadership, Cornell moved into what is now called high-energy elementary particle physics, a field in which Cornell remains on the cutting edge. In the decade following World War II, Bethe and Feynman and their students played a central role in developing quantum electrodynamics, work for which Feynman shared the 1965 Nobel Prize.

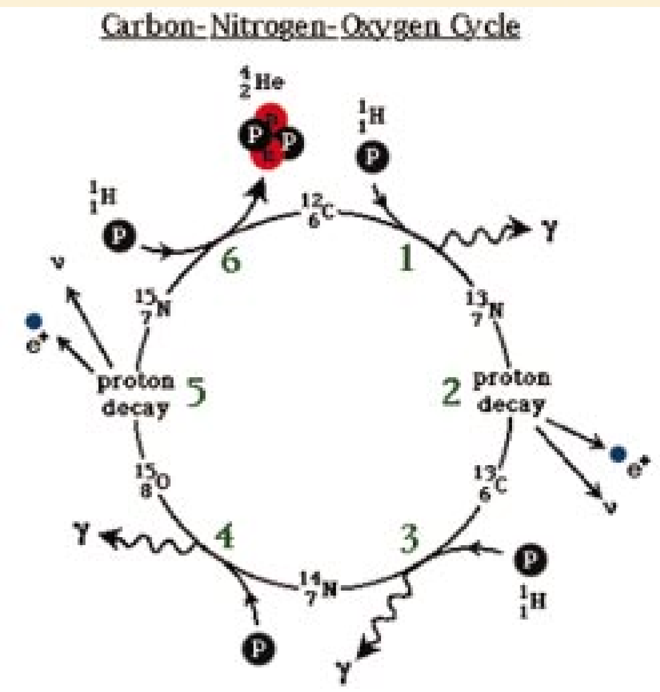
Bethe's career spans the evolution of nuclear physics, as we know it today. He has made contributions to almost all phases of the exploration of nuclear interactions and nuclear forces, but his scientific accomplishments go far beyond this. He produced the first major paper on the theory of order-disorder transitions in alloys, and his 1947 calculation of the Lamb shift paved the way for the revolution in quantum electrodynamics.

Bethe's most well known work concerned an old riddle. How has it been possible for the Sun to emit light and heat without exhausting its source not only during the thousands of centuries the human race has existed but also during the enormously long time when life evolved on Earth? None of the then known sources could account for this massive amount of energy production. It was clear that some quite unknown process must be at work in the interior of the Sun.

After radioactivity was discovered by the French physicist Henri Becquerel in 1896 a plausible explanation of the mystery appeared imminent, for in radioactivity, too, production of energy appeared almost unlimited. But the first guess that the Sun's enormous source of energy could be due to the presence of a sufficient amount of radioactive substances soon proved to be wrong. A closer study of radioactivity, however, led to a new field of physical research that would ultimately lead to the solution of the Sun's energy riddle.

During 1935-1938, Bethe studied nuclear reactions and predicted many reaction cross sections, research that was useful to him to develop Bohr's theory of the compound nucleus more quantitatively. This work was summarized in three articles in Reviews of Modern Physics, which for many years served as a textbook for nuclear physics, sometimes known as "Bethe's bible." Bethe's main achievement in astrophysics is considered to be the exclusion of many possible interactions than can happen inside the stars, leaving just two possibilities (the carbon-nitrogen cycle for massive stars and proton-proton reaction that powers fainter stars like the Sun).

In 1939 Bethe arrived at an elegant scheme to explain the mystery of stellar energy production. He calculated the Sun's energy production, which he said results from the fusion of four hydrogen atoms (each of mass 1.008) into one helium atom (mass 4.0039). No direct fusion is possible, but Bethe showed that the probabilities of the four steps of the "carbon cycle" could account for the energy output. A carbon isotope of mass 12 reacts successively with three hydrogen nuclei (protons) to form the nitrogen isotope of mass 15; energy is produced through the fusion of a fourth hydrogen nucleus to release a helium nucleus (alpha particle) and the original carbon isotope. This cycle has come to be known as the Bethe (or Bethe-Weizsäcker) cycle, or more commonly, the carbon-nitrogen (or CNO) cycle. Bethe was awarded the 1967 Nobel Prize in physics "for his contributions to the theory of nuclear reactions, especially his discoveries concerning the energy production in stars."



The carbon-nitrogen-oxygen (CNO) cycle is a cycle of six consecutive nuclear reactions that lead to the formation of a helium nucleus from four protons:

1. $^{12}C + {}^{1}H \rightarrow {}^{13}N + \gamma$
2. $^{13}N \rightarrow {}^{13}C + e^{+} + \nu$
3. $^{13}C + {}^{1}H \rightarrow {}^{14}N + \gamma$
4. $^{14}N + {}^{1}H \rightarrow {}^{15}O + \gamma$
5. $^{15}O \rightarrow {}^{15}N + e^{+} + \nu$
6. $^{15}N + {}^{1}H \rightarrow {}^{12}C + {}^{4}He$

The carbon nuclei with which the cycle starts are effectively reformed at the end and therefore act as a catalyst. This is believed to be the predominant energy-producing mechanism in stars with a core temperature exceeding about 18 million °C.

In actuality there is not only CNO cycle but three possible cycles, which are astrophysically important. The main CNO cycle looks like this:

The cycle results in the fusion of four hydrogen nuclei (^{1}H, protons) into a single helium nucleus (^{4}He, alpha particle), which supplies energy to the star in accordance with Einstein's equation. Ordinary carbon serves as a catalyst in this set of reactions and is regenerated.

The proton-proton chain reaction is one of two fusion reactions by which stars convert hydrogen to helium, the other being the CNO cycle. The process was first described in 1938 by Bethe and the American physicist Charles Critchfield. The proton-proton chain is more important in stars the size of the Sun or less.

To overcome the electromagnetic repulsion between two hydrogen nuclei requires a large amount of energy, and this reaction takes an average of 10 billion years to complete. Because of the slowness of this reaction the Sun is still shining; if it were faster, the Sun would have exhausted its hydrogen long ago.

The first step in the proton-proton chain reaction involves the fusion of two hydrogen nuclei ^{1}H (protons) into deuterium ^{2}H, releasing a positron as one proton changes into a neutron, and a neutrino.

$$^{1}H + {}^{1}H \rightarrow {}^{2}H + e^{+} + \nu$$

The positron immediately annihilates with one of the hydrogen's electrons, and their mass energy is carried off by two gamma ray photons.

$$e^{+} + e^{-} \rightarrow 2\nu$$

After this the deuterium produced in the first stage can fuse with another hydrogen to produce a light isotope of helium, ^{3}He:

$$^{2}H + {}^{1}H \rightarrow {}^{3}He + \nu$$

Finally, after millions of years, two of the helium nuclei ^{3}He produced can fuse together to make the common helium isotope ^{4}He, releasing two hydrogen nuclei to start the reaction all over again.

In general, proton-proton fusion can occur only if the temperature (i.e. kinetic energy) of the protons is high enough that they can overcome the mutual Coulomb force repulsion. The theory that proton-proton reactions were the basic principle by which the Sun and other stars burn was advocated by the English astrophysicist Arthur Eddington in the 1920s. At the time, however, the temperature of the Sun was considered too low to overcome the Coulomb-force barrier. After the development of quantum mechanics, it was discovered that the tunnelling of the wave functions of the protons through the repulsive barrier allowed for fusion at a lower temperature than the classical prediction.

Before his work on nuclear physics, Bethe's main work concerned atomic physics and collision theory. He wrote a review article on atomic physics in Handbuch der Physik in which he filled in the gaps of the existing knowledge, and which is still up-to-date. In collision theory, he developed a simple and powerful theory of inelastic collisions between fast particles and atoms, which he used to determine the stopping power of matter for fast charged particles, thus providing a tool to nuclear physicists. In 1934, Bethe and the German physicist Walter Heitler developed the quantum mechanical theory for bremsstrahlung of relativistic electrons, and initiated the theory of electron and proton showers in cosmic rays. Bremsstrahlung is the electromagnetic radiation that is produced when charged particles with energies large compared to their rest energies are decelerated over a very short distance. Since electrons are much lighter than protons, electron bremsstrahlung is the most common.

In 1947, Bethe, with the American physicist Robert Eugene Marshak, put forth the two-meson hypothesis. Later on, he worked with a large number of collaborators on the scattering of pi mesons and on their production by electromagnetic radiation. Also in 1947, Bethe was the first to explain the Lamb shift in the hydrogen spectrum, thus laying the foundation for the modern development of quantum electrodynamics. In 1948, as a joke, Bethe contributed with the American physicists Ralph Alpher and George Gamow to the famous "alpha-beta-gamma" paper on the origin of the chemical elements at the time of the big bang. In 1955, Bethe returned to the theory of nuclei, and worked then on the theory of nuclear matter.

The discovery of neutron stars led Bethe back to fundamental research in astrophysics in 1970. Although his main interest was in the rapidly developing subjects of atomic and nuclear processes, he also did some work on solid-state theory, and discussed the splitting of atomic energy levels when an atom is inserted into a crystal and applied classical mathematical methods to the calculation of electron densities in crystals, the order-disorder states in alloys, the operational conditions of reactors, the ionisation processes in shock waves, and the detection of underground explosions from seismographic records.

Bethe's published works include Elementary Nuclear Theory, a discussion of the experimental evidence concerning the forces acting inside the atomic nucleus, and Intermediate Quantum Mechanics, a theoretical description of atomic structure.

In his public role, Bethe's position has been that of a responsible scientist and a man of conscience eager to contribute his special knowledge to the public discussion of the great issues of our time. During the '80s and '90s he campaigned for the peaceful use of nuclear energy. In 1995, at the age of 88, Bethe wrote an open letter calling on all scientists to "cease and desist" from working on any aspect of nuclear weapons development and manufacture. In 2004, he signed a letter along with 47 other Nobel laureates endorsing John Kerry for president of the United States citing Bush's misuse of science. In 1958, Bethe headed a US presidential study of nuclear disarmament and was scientific adviser to the United States at the Geneva nuclear test-ban talks.

In 1999, at age 93, Bethe delivered three lectures on quantum theory to his neighbours at the Kendal of Ithaca retirement community (near Cornell University). The lectures were intended for an audience of his neighbours at Kendal, and made use of limited mathematics while focussing on the personal and historical perspectives of one of the principal architects of quantum theory whose career in physics spans 75 years. Bethe was a remarkable combination of a truly great scientist who has also made major contributions in the public service.

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As regards the serial in Gondi language, it was felt that keeping in mind the audience profile a subject like 'science in our lives' would be best suited. The serial would attempt to explain natural phenomena, demystify natural occurrences and superstitions prevailing in the community and discuss of the rich practical knowledge garnered by the community in form of the medicinal plants and techniques for weaving and so on.

The workshop was organized in association with the State Health Resource Center, Raipur and local experts such as Shri Mirza Masud (former Station Director AIR), Senior artists and Charrisgahri writers such as Shri Raj Kamal and Sh Hemanth participated on both the days. Script writers associated with AIR also took part in the workshop. Input was gathered from the State Mining and Geology department, Scientific departments of University of Raipur such as Botany, Geology etc; Dept of Tribal affairs, Department of Water resources and so on for identification of topics for each episodes of the serial.

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and was the International collaborative project initiated by Students' Research Center and Central Lab Rey City, Iran. It was planned that the experiment would be conducted at four different countries viz. Iran, India, Italy and Thailand. But, unfortunately due to cloudy weather, experiment could not conducted at Italy and Thailand. In India, the experiment was conducted at NSC New Delhi and at Inter University Center for Astronomy and Astrophysics (IUCAA), Pune. At NSC New Delhi, Mr. Arvind C Ranade, SSO (Astronomy) from Vigyan Prasar and Shri A. S. Manekar, Director, NSC, and his team members – Mr. Anurag Kumar Mr. Kailash Chandra and Mr. Sen, and at Pune Mr. Arvind Paranjapye and his group conducted this experiment.

Apart from these activities, VP had conducted a public lecture and Night Sky Watching programme at Nehru Bal Bhavan and at a housing society at Patpadgunj, New Delhi, wherein a large number of people participated enthusiastically.

The New Millennium Wonder Scopes

❑ Sandip Bhattacharya
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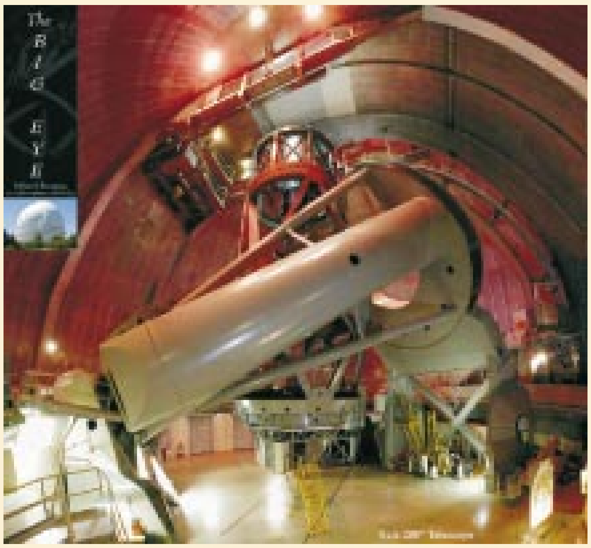
When we look at the night sky, we get wonder struck by the scale and intricacies of the macroscopic world. Beyond our common visual perception within that star spangled dark sky lay hidden even deeper mysteries. Our eyes fail to record them. So, the telescopes come in aid. A telescope primarily collects more light and converge it all at its focal plane. It is essentially a light bucket that collects light over a larger area. The bigger the telescope is, the larger is the bucket, and deeper and farther it helps us to probe the universe. The telescopes reveal the faint and the fuzzy distant objects even beyond the realm of stars in awe inspiring details.



Inner view of 'Hale Telescope' at Palomar Observatory

A new revolution in telescope technology has taken place very recently, during the transition decades of the old and the new millennium. Some of the biggest telescopes in the world have come into operation within quite a short span of time. Each one of these is a technological wonder. We hope to answer some of the biggest questions of our era utilising these wonder scopes. Let us have a tour of these facilities and explore what these innovative-scopes are all really up to.

The first revolution in telescope technology had begun in the starting decades of the twentieth century. The new generation bigger and larger telescopes no more had lenses at their front ends as the light collecting surfaces. Lenses are usually supported by their rims on the telescope tubes. If the lens is quite big and heavy it sags by its own weight and gets slightly distorted in shape. This is unacceptable to astronomers. A thick lens also absorbs a part of the feeble radiation from the distant sources that passes through it. So, the big concave glass mirrors became easy preferences for the large telescopes. The modern larger light scopes no more use lenses as their primary light gathering surfaces. A finely polished and aluminised large concave mirror has support all along its back that prevents sagging. The main mirror reflects the light from distant sources into a converging beam. A second smaller mirror at a distance from the primary deflects the focal plane at a more convenient position for research purposes. So, it is reflection all along and hardly any light is lost or absorbed in the way.

The first of such finest examples came up atop Mount Wilson in California in the beginning decades of the twenty-first century. The 100 inch diameter primary concave mirror was 13 inch thick and weighed 5 tons. The telescope was named after its primary contributor - a Los Angeles businessman, John D. Hooker and came in operation in 1917. Within six years of its installation, Edwin Hubble studied distant galaxies with this telescope and scaled the Universe.

This was the first among the four large telescopes initiated by a pioneering and visionary astronomer - George Ellery Hale. Hale's dream project was however, an observatory with a 200 inch (5.1 meter) reflecting telescope. It began to take shape in the middle of 1930s atop Mount Palomar in California. The five hundred and fifty ton giant with just the mirror weight of 15 tons, - the biggest in the entire world, finally came into operation in 1948. Hale didn't survive to see the final shape of the crowning glory of his achievements. He passed away a decade too early. The observatory was finally dedicated in his memory. For about half a century the Hale telescope has remained in the forefront of astronomical research. Operated by the Carnegie Institution, the Hale telescope during the six decades of its operation has helped detect the first Quasars. It has also contributed remarkably in the study of stellar evolution and the structure of the Universe. Many more intricate details need to be filled up yet. To seek these answers there is a greater need, than any time before, for even larger ones to probe much fainter, farther and deeper.

New Millennium Scopes

Today's telescopes are beyond the wildest dreams of Hale. Tremendous advances in computer technology and its successful marriage with opto-mechanical systems have given us almost magical powers to create each scope as a technological marvel.

Though we are still puzzling over the basic content of the Universe and its structure, an eventful future is waiting eagerly at our doorstep. The new generation telescopes that, have just come up on the verge of new millennium, hold quite a lot of promise for early break-through. How big these scopes and what are their state of the art specialities?

The largest of the fully steerable new generation behemoths are the twin Keck Telescopes with 9.8 meter primary mirrors. At 4,025 meters above the mean sea level atop a dormant Hawaiian Volcano - Mauna Kea, the telescopes are far above the thickest lower atmosphere of the Earth full with humidity, dust, smog and the clouds. Thousands of miles of surrounding ocean stabilise the air column above the volcano quite remarkably. An unstable atmosphere, above, produces a twinkling effect in the heavenly objects. This never allows the object to be at its sharpest focus.

Indeed, the Earth's atmosphere plays spoil-sport in astronomical observations. The atmosphere is not exactly transparent for all the radiation from the distant sources. This life giving protective blanket around the Earth absorbs and prevents the harmful Gamma rays, X-rays and the ultra-violet radiation from reaching the ground level. The atmosphere has a transparent window that allows only the visible radiation to reach the surface unhindered. This window is, however, not that transparent for heat radiation or the infra-red rays. The infra-red rays have free-pass through this window only at selected wavelength ranges. The atmospheric molecules block the other wavelength bands.

Galaxies, galaxies everywhere - as far as the NASA/ESA Hubble Space Telescope can see. This view of nearly 10,000 galaxies in the deepest visible-light image of the cosmos. Called the Hubble Ultra Deep Field, this galaxy-studded view represents a 'deep' core sample of the universe, cutting across billions of light-years.

The thin air atop Mauna Kea is ideal for telescopes that primarily observe the sky in the optical and the infra-red band. This sixty percent thinner moisture free air is not as much a blockade for the infrared rays as the thicker moisture laden sea-level air is. No doubt, Mauna Kea remains the chosen site for the largest number of world's greatest telescopes.

Northern Telescopic Kingdom

Unlike the older generation telescopes, the eight stories high and 300 ton massive Keck telescopes are not made of monolithic primary mirrors. Instead, each telescope is an ensemble of 36 separate hexagonal pieces. Computer controlled actuators at the back of each segment hold these pieces accurately to their respective places. The resulting mirror is the world's largest one - 9.8 meter in diameter. The first of the twins - Keck-I came in operation in May 1993. Within three years Keck II with exactly the same specification came up just 100 meters apart. The ultimate aim is to join the light beams from the two telescopes. This will effectively increase the resolving power of the twins equivalent to a single 95 meter telescope.

Just 500 meters apart, giving company to the Kecks is the cylindrical dome of National Astronomical Observatory of Japan's 8.2 meter diameter and 500 ton massive scope - Subaru. "Subaru" stands for the Pleiades star cluster in Japanese.

The present generation scopes are high in technology so goes the cost of construction of such facilities. With a couple of exceptions the present trend is towards collaborative efforts between universities, private research organisations as well as nations.

The Gemini Project's 8.1 meter Gemini North telescope, with its unique hamburger shaped dome, is a fine example of seven-nation collaboration of Canada, USA, Argentina, Brazil, Australia, Chile and the United Kingdom.

With all this and more Mauna Kea, Hawaii has turned into a veritable kingdom of large telescopes in the northern hemisphere. Today, thirteen telescopes from 11 nations dot this volcanic barren landscape.

Southern Telescopic Kingdom

The European Southern Observatory (ESO) consortium, formed by six European nations - Belgium, France, Germany, Netherlands, Denmark, and Portugal, had set up its first observing facility at La Silla, in the driest Atacama Desert of Chile, in the 1960s, to explore the southern sky. Since then, Italy, Sweden, Switzerland, United Kingdom and Finland have joined in to strengthen the consortium. ESO's first prestigious flagship observing facility - The Very Large Telescope (VLT) Array has just come up at Cerro Paranal, 600 kilometres north of La Silla, at an altitude of 2,635 meters. The VLT is four 8.2 meter diameter large interconnected telescopes placed in the configuration of a trapezoid. The observable wavelength range of the telescopes is from near Ultra Violet to 25 microns in the infrared.

"Subaru" a Japan National Large Telescope on the summit of Mauna Kea

The Keck Foundation in collaboration with the University of Hawaii operates the 150 million dollar facility of world's largest telescopes.

Except the four large ones, there will be four movable 1.8 meter auxiliary telescopes. When fully completed, in 2010, the light from all the telescopes can be combined in an underground tunnel by the VLT Interferometer. The interferometer pattern would produce an effective resolution equivalent to a 200 meter large mirror, that's again equivalent to seeing a single astronaut standing on the Moon.

Each of the largest unit-telescopes of the VLT is named in local Mapuche language. The first one is called "Antu" - the Sun, the second, "Kueyen" - the Moon, the third, "Melipal" - the "Southern Cross" and the fourth, "Yepun" - the Evening Star.

Little north of La Serena, in the southern Atacama Desert is Cerro Pachon at 2737 meters above sea level. It hosts the southern kingdom's another crowning jewel - the 8.1 meter twin of Gemini North - the Gemini South.

Active and Adaptive Optics

A large telescope also has a high resolving power - the power to clearly discern two quite closely spaced objects. This is comparable to human vision acuity or sharpness of vision. As a thumb rule, this minimum angle of resolution is directly proportional to the wavelength of observation. The size of this angle is also inversely proportional to the diameter of its main mirror. Larger the mirror smaller is the angle of resolution and better is its resolving power. This is the incentive for astronomers towards building bigger and bigger telescopes. Technology permitting, astronomers would like to go for even larger telescopes than that are available in the world today.

However, very large mirrors not only require massive support structures they also sag under their own weight. The Keck Telescopes have resolved the problem by opting for thin segmented mirrors, instead of a huge monolithic one.

The Subaru, Gemini and the VLT use light weight and ultra-thin monolithic mirrors. Computer actuated supporting pistons at the back strategically push and pull the mirrors to neutralise the effects of sagging. This is active optics. Without such an active deformation correction system, scientific observations would be impossible.

Human ingenuity has not stopped at developing active optics technology alone. It has gone far beyond that. Our ingenuity has allowed us to compute the effects of air mass-unrest above-head. Miles of atmospheric layers remain in constant turmoil as temperatures keep changing. This disturbs and distorts the incoming light waves from distant objects. The distorted wave-front degrades the image quality and reduces sharpness of the image. In astronomical parlance this effect is known as "Seeing". An exceedingly fast image analyser measures the image quality and sends corrective signals up to 100 times every second to a small deformable mirror. This small mirror is placed before the focus in the light path of the telescope. Deformations in the mirror neutralise the effects of "seeing". Such extremely sophisticated "adaptive optics" technique produces ten times sharper image.

Incorporating the active and adoptive optics technology the modern-day giant scopes are regularly producing quality images that are even sharper than space-based telescopes and are breaking new frontiers in astronomical observations.

World's third largest one

Our virtual tour of the world's wonder scopes can never be complete without the mention of McDonald Observatory's unique Hobby-Ebberly Telescope (HET). HET is the world's third largest optical telescope, after the twin Kecks, with an effective mirror diameter of 9.2 meters. 91 identical hexagonal segments supported by computer controlled actuators make the primary reflecting surface of the telescope.

A conventional telescope keeps track of a heavenly object by simultaneous computer controlled movements in altitude as well as in azimuth. HET however, permanently points at a fixed elevation 550 above the horizon. To acquire an object within its field of view, its base rotates only in azimuth along a horizontal plane. This arrangement allows 70% of the sky accessible to the telescope.

The tracking system in HET is also entirely different from its sister scopes. During an observation run the telescope does not move at all. There is a movable tracker installed at the focus 13 meters above the main segmented mirror. As a star slowly changes its position in the sky, the tracker constantly moves along a six-axis co-ordinate system and tracks it across the field of view. The 8 ton tracker also carries a camera, correcting optics, a low resolution spectrograph and fibre feeds to spectrographic instruments located in the basement below the HET.

The Hobby - Ebberly is a multi-nation, multi-university project jointly shared by - University of Texas Pennsylvania State University, Stanford University, Ludwig Maxmillans University, Munich and George August University, Goettingen. The telescope has been built specifically for spectroscopy work. By making the telescope's structure stationary, the cost of construction has been reduced by about 80% compared to similar sized telescopes in the world.

Nostalgia of the Olden Days

Observational astronomy has undergone a sea-change since the days of Hubble, so have the scopes, the instruments, the technology and our knowledge base. The huge cost of the modern-day biggies put a premium on their observing times. Every hour of observing time needs to be put in good uses if the conditions are right outside and all systems are in go. On many occasions, staff-scientists carry out the observations in queue and communicate the data to the researchers at the other end of the world. The days are not far off when astronomers sitting in the cosiness of their offices in front of computer terminals will be able to carry out their observations at a remote and fully automated observatory thousands of kilometres away.

However, it will always remain a cherishable experience observing the heavens sitting beneath a huge telescope with the dazzling array of stars overhead visible through the open slit of the dome. The eerie, unearthly environs in the midst of the whining noise of the telescope motors help one to fathom the real vastness of the universe. It is here one can feel the oneness with even the remotest thing in this unique creation.

Himalayan Chandra Telescope

Indian participation in building such large observing facilities is yet to begin. However, we can be proud of new advanced 2 meter telescope, that came up at a remote village of Hanle, about 4,517 meters above the sea label, in the Himalayan in Ladakh in 2001. This makes it the highest astronomical observatory in the world, beating the University of Denver operated Meyer - Womble observatory, high in the Rockies, by a clear margin of 200 meters. Christened the Himalayan Chandra Telescope, it is operated remotely from Hoskot near Bangalore, some 2000 kilometers away. The telescope is named after the India - born nobel winning astrophysicist Subramanium Chandra Shekhar. The unique humidity, dust and cloud free high altitude thin air location of this 80 million dollar facility has generated a keen interest in the international astronomical community for collaborative projects. If everything goes according to plan, then by 2010 a six to eight meter binocular telescope will also come into operation in this high altitude cold barren desert. Other interesting plans are also in the drawing board of Japanese and US astronomers.

Sandip Bhattacharya, *Asst. Director, B.M. Birla Planetarium, Statue Circle, Jaipur-302 001*

Obituary

Philip Morrison

Scientist and Science Populariser

Philip Morrison, the famous scientist from the Massachusetts Institute of Technology, died on 22 April 2005 at the age of 89. Though disabled by polio in his childhood, he was one of the most innovative and energetic scientists of the twentieth century. He was a well known science communicator as well.

In 1945 Morrison helped to assemble, with his own hands, one of the atomic bombs dropped on Hiroshima and Nagasaki. He was a part of the team that surveyed the cities a month later. Morrison went on to work in high-energy astrophysics, including the origins of cosmic rays. In 1959 he coauthored a paper in *Nature* establishing the plausibility of what came to be called Search for Extra Terrestrial Intelligence or SETI — using radio telescopes to search for evidence of intelligent life in other parts of the Universe.

V.B. Kamble with Philip Morrison at the latter's residence in Boston (1986)

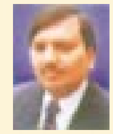
I had the good fortune of having known him for over two decades. I first met him and his wife Phylis in the mid-eighties at Ahmedabad, when he was visiting the Physical Research Laboratory and Vikram A. Sarabhai Community Centre, where I was a scientist then. Later, I called on him and Phylis at their residence in Boston. It was then that I discovered yet another facet of his life - he was a wonderful cook! He even prepared a pudding for me!

Philip Morrison will long be remembered as one of the designers of the first atomic bomb, and a lifelong advocate for nuclear disarmament thereafter. He was a pioneering figure in high-energy astrophysics and cosmology, an originator of the search for extraterrestrial intelligence, and a science communicator through his numerous books and articles. In particular, his film "Powers of Ten," and his PBS television series "The Ring of Truth" stand out as the finest examples in science popularization. He authored a long-running column in *Scientific American* with Phylis, who died in 2002.

❑ **V. B. Kamble**

Heat and Dust

Simple Remedies for Summer Disorders



❑ Dr. Yatish Agarwal
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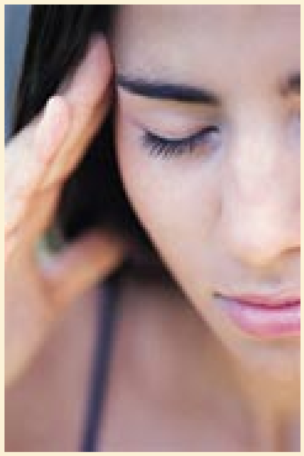

Under normal conditions, your body's natural control mechanisms—skin and perspiration—adjust to the heat. However, the Indian summer can buckle the stoutest of bodies. These systems may fail when you are exposed to high temperatures for prolonged periods. You should therefore learn to pick the first signs of heat related problems and act before the situation gets out of hand.

SUMMER RASH

Heat rash, or prickly heat, is a common problem during the summer months. Children, men and women all may suffer. The condition occurs due to blocked sweat glands. The sweat collects underneath the skin, invites a skin reaction, and leads to tiny pimple-like spots. The surrounding area becomes a stingy red and you experience irritation and itching. Called *miliaria rubra* in medical jargon, the rash is most severe in such parts of the body, which come in close contact with clothing. Infants and overweight people, who sweat more profusely, suffer most.

REMEDIES

- **Move to a cooler climate :** The first basic principle to treat heat rash is to move to cooler conditions. Stay in an air-conditioned room. Or better still, pack your bags and move to the mountains. This would reduce sweating to a minimum, unburden the sweat glands and give sweat ducts opportunity to recover. Ten days of this therapy shall free you of heat rash.
- **Use calamine lotion :** Calamine lotion acts as a cooling agent and relieves itching. Apply it three or four times a day.
- **Take Vitamin C :** You may also chew one gram of ascorbic acid daily. It might stimulate quick recovery.
- **Wear loose-fitting clothes :** Wear loose-fit clothes made out of soft fabric such as cotton. Change frequently. Make sure that your clothes are rinsed well after washing. Irritant detergents, rough clothing and tight dresses can worsen heat rash.
- **Use gentle soaps :** Frequent bathing and excessive use of soap, especially a harsh soap, and unnecessary application of medicaments do not help. They can worsen the condition. The best is to use a mild soap containing hexachlorophene.
- **Avoid the culinary sweat :** Hot foods laden with spices and condiments, curries and *tikka* stuff increase sweating and can make heat rash worse.
- **Curtail the cocktail :** Alcohol increases sweating and therefore, it is best to restrict it.
- **Check weight :** Being obese makes you sweat more. You must try and lose weight, if you find the scale tipping wrong side.
- **Do not scratch :** Scratching can lead to secondary bacterial infection.

HEAT CRAMPS

Heat cramps are painful muscle spasms. They usually occur after vigorous exercises and profuse perspiration. Your abdominal muscles and calf muscles are most likely to get affected.

REMEDIES

- **Take it easy :** Rest briefly; cool down. If you are carrying a cricket bat on the field or marching to the bowling run up, it's time to take a break in the pavilion.
- **Replenish salt and water :** Eat salty foods. Drink water with a teaspoon of salt per litre.

HEAT EXHAUSTION

Signs of heat exhaustion include an increased temperature, faintness, rapid heartbeat, low blood pressure, an ashen appearance, cold, clammy skin and nausea. Symptoms often begin suddenly, sometimes after excessive perspiration and inadequate fluid intake.

REMEDIES

- If you suspect heat exhaustion, move out of the sun and into a shady spot or air-conditioned location. Then, lie down. Elevate your feet slightly.
- Loosen or remove your clothing.
- Take cold (not ice) water to drink, or an electrolyte-containing drink such as one supplemented with Electral or Prolyte mix. Although less dangerous than heatstroke, never treat heat exhaustion lightly. It can quickly turn into heatstroke.

HEATSTROKE

If you are negligent about your fluid and salt intake, indulge in vigorous exercise, or use alcohol, you are vulnerable to suffer heatstroke. Elderly, obese people and heart patients are particularly at risk.

- **Recognise the signs :** The body temperature goes up to between 102 and 104 degree Fahrenheit. Heartbeat becomes rapid. Breathing is rapid and shallow. Mental confusion may occur. Fainting can be the first sign. The victim may suffer headache, chills, and nausea and vomiting. A victim may stop sweating, but this is not a reliable sign.

MANAGEMENT

If you suspect heatstroke, get emergency help immediately.

- **Move the victim out of the sun :** Shift the person into a shady spot or air-conditioned space and give the victim a sponge bath. If the situation is more serious, wrap the person in wet sheets. This will help the lower the body's internal temperature quickly and hasten recovery.
- **Replace fluids and salt :** If the person is conscious, give him cold water to drink. Add a teaspoon of salt to one litre of water to replenish salts. If, however, the victim is feeling severely nauseated or is vomiting, have a doctor attend on him. Intravenous fluids should be best in that situation.
- **Improve circulation :** Raise the legs of the victim, and rub his legs to improve the blood flow to the heart.
- **Know the danger signals :** If the victim suffers further increase in body temperature, stops to sweat or his skin becomes hot and dry, rush him to a hospital. If you are away from civilisation, do not panic. Act quickly to lower his body temperature. Move him to a cool place. Pour cold water on him and fan him. Take his temperature every 15 minutes if possible and stop pouring cold water on him only when his temperature comes down to 100 degree Fahrenheit. Look for medical aid.
- **Prevention is better than cure :** The best course is to work at prevention of such emergencies. Exert yourself in the heat only if it's a must and drink lots of water with salt throughout the day. Carry a water bottle or a large jug with you, and use it!

Bridging the Divide *(contd. from page 31)*

would provide an interactive channel for students with experts and could include talks, lectures / demonstrations, discussions, question-answer sessions, and also can be utilised for education on natural disasters and relief operations. Talkback terminals and receive-only terminals could be set up at selected rural schools that could also be utilized by other schools in the neighborhood. Satellite Radio also can prove to be an important tool for education and development in India.

ICT as a tool should be used with care so that it serves to bridge the social divide and equalize opportunity; inappropriate and insensitive use may in fact widen the divide. Given the growing reach of the technology it is imperative that efforts are initiated to utilize ICT to face the challenges of a society that is fast transforming into information driven society.

❒ **V. B. Kamble**

Science activity kit on Astronomy

Price: Rs 70 + Rs 20 postal charge

The activity kit on Astronomy is useful to the people in general and students in particular to learn about Astronomy through different activities. Twenty five activities are provided in the kit. Make your own Sun Dial, model of Venus Transit, Measuring the altitude of stars, Star Dial, quiz on Astronomy are examples of some of the activities. The kit is available in English and Hindi versions.

Recent Developments in Science & Technology

PSLV Successfully Launch CARTOSAT-1 and HAMSAT

PSLV Successfully Launched CARTOSAT-1 and HAMSAT into high polar orbit by ISRO's Polar Satellite Launch vehicle PSLV-C6 on 5th May 2005 from Sastish Dhawan Space Centre Sriharikota. Both the satellites have been placed in polar Sun Synchronous Orbit (SSO) at an altitude of 632 x 621 km with an inclination of 97.8 deg with respect to the equator. The solar panels of CARTOSAT-1 were deployed soon after its injection into orbit. PSLV was designed and developed by ISRO to place 1,000 kg class Indian Remote Sensing satellites into polar Sun-synchronous Orbit (SSO).

CARTOSAT-1 (1560 kg) is the eleventh satellite in the Indian remote sensing satellite series. It is intended for cartographic applications. It carries two panchromatic cameras that take black-and-white stereoscopic pictures in the visible region of the electromagnetic spectrum. The imageries will have a spatial resolution of 2.5 metre and cover a maps for urban and rural development, land and water resources management, disaster assessment, relief planning and management and environmental impact assessment. CARTOSAT-1 also carries a Solid State Recorder with a capacity of 120 Giga Bits to store the images taken by its cameras.

HAMSAT(42.5kg) is a Micro-satellite for providing satellite based Amateur Radio services to the national as well as the international community of Amateur Radio Operators (HAM). It will meet the long felt need of the Amateur Radio Operators in the South Asian region who possess the required equipment and operate in the UHF/VHF band based Satellite Radio Communication. One of the transponders of HAMSAT has been developed indigenously involving Indian Amateurs, with the expertise of ISRO and the experience of AMSAT-INDIA. The second transponder has been developed by a Dutch Amateur Radio Operator and Graduate Engineering student at Higher Technical Institute, Venlo, The Netherlands.

HAMSAT is India's contribution to the international community of Amateur Radio Operators. This effort is also meant to bring ISRO's Satellite services within the reach of the common man and popularise science and technology among the masses.

Source: isro.org

Desktop Fusion Machine

Scientists have invented a desktop fusion machine. It sounds like the biggest science story of the century.

If nuclear fusion can be made to happen at room temperatures and pressures in an average lab, then one might think the world's energy crisis is over. But the inventors of the device stress that their gadget cannot generate power at all, because it does not support a self-sustaining thermonuclear reaction. Instead, they say, it has a whole host of other applications, from treating cancer to powering spacecraft.

Seth Putterman, a physicist from the University of California, Los Angeles and his team invented this machine. He used pyroelectric crystal of lithium tantalite in his machine, which produces a strong electric field when heated to room temperature from freezing. This field is focused until it is powerful enough to accelerate a beam of deuterium ions (proton-neutron pairs) to about 1% of the speed of light.

When these ions hit a target containing deuterium nuclei, they fuse to form helium-3, a combination of two protons and a neutron. The process emits about 1,000 neutrons a second, and by allowing the crystal to heat up slowly, fusion can be sustained for as long as eight hours. Detailed of his toaster-sized device has been published in science journal-Nature.

Source: Nature.com

Fifteen years of Hubble

Hubble has completed its 15 years. It is part of NASA's Great Observatories Program. Fifteen years ago on 25 April 1990,Hubble Space Telescope, hailed by some commentators as the most successful astronomy mission ever, was placed in orbit. It has snapped 750,000 images, sending 120 gigabytes of data back to Earth each week.

Hubble's most impressive achievement is to have peered into the farthest recesses of the Universe, allowing cosmologists the chance to witness the first stars in the act of formation. Images called the Hubble Ultra Deep Fields taken using lengthy exposures of around a million seconds, capture light from so far away - which has travelled for so long to reach us - that the pictures show astronomers what was happening almost as far back as the Big Bang.

In recent years, Hubble has also taken ultraviolet images of Saturn's striking aurorae captured high-speed galactic collisions , and create interest among the astronomers.

Source: Nature.com

Earth absorbing more heat than it radiates

The Earth is absorbing more energy from the Sun than it is emitting to space, according to a new modeling study. The difference amounts to 0.85 watts for every square meter of the planet's surface. That is equivalent of 7 trillion 60-watt light bulbs - or the energy output of almost half a million thousand-megawatt power stations.

Most of the extra heat is warming the oceans - the ultimate repository of most of the solar radiation reaching the Earth, says Jim Hansen, director of NASA's Goddard Institute for Space Studies in New York, US, and a leading climate change scientist for the past two decades. The findings are the result of modeling studies of the atmosphere's "energy budget" by a US team, headed by Hansen. The calculations are supported by precise measurements of ocean temperature over the past 10 years.

The conclusion provides evidence both of planetary warming and of the lag in the response of the planet to the warming created by the accumulation of greenhouse gases in the atmosphere - gases which trap infrared heat, preventing it from dissipating into space.

Source : Newscientist.com

Compiled : Kapil Tripathi