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# DREAM 2047

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## VP News

## Vigyan Rail – Science Exhibition on wheels

Vigyan Rail made its journey in the month of July 2004 to seven locations; Agra, Jaipur, Kota, Ajmer, Jodhpur, Bikaner and Firozpur. In all the places extensive press and electronic media coverage was given by Newspapers, DDK, AIR and other private TV channels. Volunteers were trained to explain the exhibits in local language.

The Vigyan Rail exhibition at Agra was from 04 to 07 July 2004. The exhibition at Agra was inaugurated by Dr. G. C. Saxena, Vice Chancellor, Dr. B. R. Ambedkar University, Agra. Shri M. Suresh, DRM, Agra Division, Shri Nitishwar Kumar, District Magistrate and Dr. Roshan Lal, Chief Medical Officer and other dignitaries were present during the inauguration. In four days, some 75,000 people visited the exhibition.

The next halt of Vigyan Rail was at Jaipur during 08-12 April 2004. Shri Rakesh Mohan Agarwal, General Manager, NW Railways inaugurated the exhibition. Shri A. K. Verma, DRM, Sh H. K. Kala, ADRM, Shri S. B. Gandhi, Sr. DGM and Chief PRO and Ms. Roli Singh, Director, Department of Science and Technology, Rajasthan were present during the inauguration.There was huge crowd of school children from the second day of the exhibition. Platforms and over bridges were packed with thousands of school children. In five days, over one lakh people visited the exhibition.

*contd. on page....19*

## Inside



## Coordination meeting on EDUSAT Science Channel

Development and Educational Communication Unit (DECU), ISRO, and Vigyan Prasar, DST have jointly planned to launch a dedicated television science channel. The idea is to make knowledge about science, engineering and technology accessible to all sections of the society, thereby empowering people to take initiatives based on this knowledge. The emphasis would be on method of science. As part of this initiative, a series of workshops, conferences and meetings of scientists, educationists, teachers, students, NGOs and other concerned community members were organized in different parts of the country and a vision statement was developed.

*contd. on page....29*

*From L to R: Hon'ble MOS Shri Kapil Sibal, Prof. V.S. Ramamurthy, Dr. V.B. Kamble*

*From L to R 1st Row: Shri B.S. Bhatia, Shri Bhaskaranarayanan, Prof. E.V. Chitnis, Prof. Yash Pal.*

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

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Editor : Dr. V.B. Kamble

# Into ever-widening thought and action

Until three decades ago, black holes were awesome creatures that boggled the imagination. Black holes were first suggested over a hundred years ago, but their existence could be ascertained by solutions to Einstein's equations for general relativity only in the early part of 20th century. What are black holes? Black Holes represent the final stage of evolution for some very massive stars following total gravitational collapse. When a star with mass about one and a half times the mass of the Sun has burnt all its fuel, it would not be able to support itself against its own gravity. The star then explodes into a supernova. The stuff that is left collapses down to an extremely dense object known as a neutron star. If the star is too large, say about twice the mass of the Sun or more, the gravitational forces overwhelm the pressure gradients and collapse cannot be halted. The star continues to shrink until it finally becomes a black hole. A black hole is a region of space-time from which nothing, not even light, can escape, because gravity is so strong. Because of its strong gravitational field, it can gobble up matter and light from the outside. It has even been suggested the end of the universe will be its becoming a single black hole!

This was our understanding of the black holes until Stephen Hawking, the famed cosmologist, published in 1974 a landmark paper titled "Black Holes Ain't So Black." Hawking showed that due to quantum effects, black holes slowly radiate particles into the surrounding space — essentially an infinitesimal trickle of particles, that later on came to be known as the Hawking radiation. Most physicists quickly accepted Hawking's idea. As the black hole evaporates, its size decreases and it evaporates even more rapidly in a flood of Hawking radiation.

Hawking further argued that anything swallowed by a black hole remained forever hidden from the outside universe. What comes out of a black hole when it radiates will be different from what fell in! Only the energy will be the same. The black hole would gradually evaporate and then disappear in a final explosive outburst – taking with it the crucial information about how it was formed forever. Hence black holes would not preserve any record of the material they swallowed. In other words, we cannot retrace the history of the black hole from the particles and the radiation it emitted. Hawking and a few experts in general relativity argued that the extreme gravitational forces in a black hole would literally scrunch the information out of existence. Physicists, however, did not feel at ease with this conclusion, since it violated a fundamental principle of quantum mechanics – the theory that explains the behaviour of matter and energy at subatomic level. In quantum mechanics, it should always be possible to theoretically trace back the initial conditions of a physical system to its origin. Hence, most physicists thought that a black hole must somehow retain a memory of the material from which it was formed.

Recently, in the 17th International Conference on General Relativity and Gravitation in Dublin, Ireland, Hawking admitted that he was wrong. He now believes that black holes do not destroy everything that is sucked into them. Instead, information which describes the core characteristics of every type of particle, leaks from the black hole over time. In other words, if one were to jump into a black hole, one's mass energy would eventually be returned to the universe, but in a mangled form which nevertheless would contain the information about what one had been like. In 1997, John Preskill, physicist at Caltech and Hawking made a bet for a baseball encyclopaedia as to whether black holes preserve information. Preskill bet yes, Hawking bet no! Soon after conceding the defeat, Hawking bought the encyclopaedia and got it shipped across the Atlantic to Preskill.

In his presentation at Dublin, Hawking used a concept known as imaginary time, and argued that in imaginary time, black holes preserve information. But many physicists do not think the paradox can be resolved this way. "We should stick with real time, not imaginary time," says physicist Samir Mathur of Ohio State University. Earlier this year, Mathur and his colleagues used string theory to show how black holes can indeed preserve information. Though physicists agree with Hawking's conclusion, they do not buy his argument! Did he go wrong once again? But, how can we expect any progress if we do not make mistakes?

What we have described here is Stephen Hawking's constant struggle for three decades to explain an elemental paradox in scientific thinking despite a crippling disease that does not allow him to write or even to speak clearly. He is neither afraid nor shy of telling the world that he was wrong. Anyone can make mistakes or jump to wrong conclusions. But, greatness lies in admitting the mistakes and taking corrective measures, alongwith clear stream of reason and tireless striving for perfection. This is scientific spirit in the true sense.

Mistakes are the road to progress provided we learn from them. This holds true not only in pursuit of science and at individual level, but also in every field of human activity and even at national level. Let us not be afraid of making mistakes, and let us not feel shy of admitting them, but let us ensure we do not repeat them in future. We shall then be led forward into ever widening thought and action.

**❒ V. B. Kamble**

**Editor** : **V.B. Kamble**

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# George Gamow

## Scientist and Science Populariser

❑ Subodh Mahanti
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Gamow made many contributions to nuclear and atomic physics, but he is mainly noted for his work on interesting problems in cosmology and molecular biology.

*A Dictionary of Scientists, Oxford University Press, 1999*

Gamow was fantastic in his ideas. He was right, he was wrong. More often wrong than right. Always interesting; and when his idea was not wrong it was not only right, it was new.

*Edward Teller*

He (Gamow) raised popular science writing to a fine art. Interestingly, some of his serious colleagues felt that he was wasting his time with these trivial pursuits! I only wish we had more Gamows in our own country who would come forward and write for the uninitiated. This can make learning science an inspired process and help take out some of the drabness of science curriculum in schools and colleges.

*S. Mahadevan in his Editorial, Resonance, July 2004*

The year 2004 is the birth centenary of George Gamow, a highly creative scientist and who by his superb popular writings made abstract concepts of science accessible to millions of laypersons or the uninitiated ones. Gamow was a first class physicist. However, Gamow's attitude to physics was larger than life. He was particularly known for finding the right scientific problems for research and introducing conceptual simplicity to them. Gamow was a pioneer in theoretical investigations of atomic nuclei. He proposed a so-called nuclear fluid model of the nucleus. Gamow's model of alpha decay (a form of radioactive decay) represented the first application of quantum mechanics to the study of nuclear structure. He also described beta decay (another form of radioactive decay). Gamow's interests were not confined within the bounds of physics. His ideas influenced research in a variety of topics. Gamow made important advances in both cosmology and molecular biology. He studied the structure and evolution of stars and creation of elements. He showed how the collision of nuclei in the interior of the Sun could produce the nuclear reactions that produce the energy. Gamow was a major expounder of the 'Big Bang' theory of the origin of the universe. He suggested how DNA might provide the code for protein synthesis. Gamow is regarded as one of the greatest science popularisers of all time.

*George Gamow*

George Gamow (his original name in Russian was George Antonovich Gamow) was born on March 04, 1904 in Odessa, Russia (now in Ukrain). His father was a school teacher. Astronomy fascinated Gamow since his early school years. He used to patiently examine the starry sky through a little telescope presented by his father. During 1923-29 he studied optics and cosmology at the University of Leningrad (St Petersburg). Before joining the University of Leningrad, Gamow had spent a year (1922-23) at the Novorossia University in his hometown, Odessa. In 1926 Gamow attended summer-school in Gottingen in Germany. During his PhD work Gamow explained the then mysterious phenomenon of natural radioactivity as well as Rutherford's experiments on the induced transformation of light elements by applying the newly developed quantum theory.

In 1928 he received his PhD degree from the University of Leningrad. After receiving his PhD Gamow went to work at the Institute of Theoretical Physics in Copenhagen, where Niels Bohr (1885-1962) became very interested in his work. Bohr offered Gamow a one-year scholarship (1929-30) from the Royal Danish Academy. While working there Gamow proposed a hypothesis that the atomic nuclei can be treated as little droplets of so-called nuclear fluid. In this model, called the liquid drop model of the nucleus, neutrons and protons behave like the molecules in a drop of liquid. John Archibald Wheeler (1911- ) and Niels Bohr adopted this model for explaining the process of nuclear fission. Wheeler and Bohr proposed that the spherical nucleus may get distorted into dumb-bell shape and when sufficient energy is acquired by the nucleus, say, by absorption of a neutron, the nucleus splits into two fragments. And in this process

energy is released. These discoveries led to today's theory of fusion and fission. During 1929-30 Gamow worked in Cambridge University with Ernest Rutherford (1871-1937) as Rockefeller Fellow.

*Niels Bohr*

In 1931 Gamow was asked to return to the erstwhile Soviet Union to join as Master of Research at the Academy of Science in Leningrad. In those days Joseph Stalin (1879-1953) was in power. Gamow and his wife wanted to leave USSR. In their first attempt to escape from Russia, they planned to go to Turkey by crossing the Black Sea. They undertook this journey of 270 km on a small boat (kayak). After continuing their journey for 36 hours they had to abandon it because of bad weather. They came back. Gamow somehow could convince that they were carrying out some experiments on the boat. After making a few more unsuccessful attempts they finally got a chance to realize their goal. In 1933 Gamow was permitted by the authorities to attend the Solvay Congress in Brussels. Gamow's wife Lyubov Vokhminzeva was also allowed to go as his Secretary. They did not return to the Soviet Union. After getting an invitation for lecturing at the University of Michigan, Gamow and his wife left for USA in 1934. While in USA, he was offered a professorship at the George Washington University. For excepting the offer he put forward three conditions; His first condition was that the university also appoint a colleague of his choice to work with him in the physics department. His choice was Edward Teller (1908- ), who was then working at Birbeck College in London. His second condition was the support of Cloyd Heck Marvin, the president of the university, and Merle Antony Tuve (1901-82), Director of the accelerator laboratory at the Carnegie Institution of Washington, in organizing a conference on theoretical physics to be held annually in Washington under the joint auspices of the university and the Carnegie Institution. The third condition was that his initially appointment in the George Washington University be described as Visiting Professor. The conditions were accepted by the University authorities. In his early years at the George Washington University, Gamow's collaboration with Edward Teller on the theory of beta decay

*Merie Antony Tuve*

*Ernest Rutherford*

(that is emission of electrons from the nucleus) led to the formulation of the so-called "Gamow-Teller Selection Rule for Beta Emission". Among his other research works carried out while working at the George Washington University were: the theory of the internal structure of red giant stars, the theory of so-called Urca process (jointly with Mario Schoenberg) and the theory of the origin of chemical elements by the process of successive neutron capture, jointly with Ralph Asher Alpher (1921- ). The beta decay or the emission of an electron from the nucleus is accompanied by the emission of a neutrino. When a nucleus captures an electron an antineutrino is emitted. Gamow proposed that when these processes take place in the interior of stars the resulting neutrinos and antinutrinos escape, and matter in the stellar interior can rapidly loose energy. Gamow called this process `Urca process' after a casino in Rio de Jeneiro where the customers lose money easily.

During the Second World War, Gamow worked in the Manhattan Project, developing an atomic bomb. Gamow also took part in the research at Los Alamos which finally led to the production of the Hydrogen bomb.

*John Archibald Wheeler*

In 1948 Gamow and his colleague Ralph Alpher wrote a paper about the Big Bang theory and how matter originated. Gamow proposed that the matter of the universe originally existed in a primordial state called the "Ylem". Helium and perhaps other elements formed from the "Ylem" shortly after the Big Bang had started the Univers's exapansion. The Big Bang theory was originally proposed by Absbe Georges Edouard Lemaitre (1894-1966).

In his last years Gamow started working in biology. He made a major contribution to the problem of how the order of the four different kinds of bases (adenine, cytosine, thymine and guanine) in DNA chains could control the synthesis of proteins from amino acids. He proposed that short sequences of the bases could form a 'code' capable of carrying necessary information for the synthesis of proteins. As there are only twenty amino acids that make up all the proteins, the code must consist of blocks of three bases because then only it will have a vocabulary of sufficient instructions. It cannot

be one base for one amino acid because then there will be only four amino acids. If two bases code for one amino acid then they could produce only 4x4 = 16 amino acids. So it would therefore need a sequence of three bases to code for one amino acid, with a capacity of 4x4x4 =64 words, which was more than adequate for the construction of all proteins. Gamow's coding scheme generated a great deal of interest among scientists working in the concerned fields. His great innovation was the introduction of mathematical reasoning to the coding problem without going into much biochemical details. For regular exchange of ideas on the coding problem Gamow formed the so-called RNA Tie Club consisting of 20 hand-picked scientists corresponding to the 20 amino acids. Each member of the Tie club was given the nickname of an amino acid , and all were presented with a diagrammed tie and tiepin made to Gamow's specifications. Though the members were located in different parts of the world, the Tie Club brought physical scientists and biologists together to work on one of the most challenging problems in modern science. The concept of code for transferring genetic information was casually mentioned by Watson and Crick in a 1953 article. However, this was first publicly articulated in an article published in late 1954 by Gamow, Martynas Ycas and Alexander Rich. By 1960 it was shown that Gamow's central idea was correct.

*Ralph Asher Alpher*

In 1956 Gamow joined the University of Colorado as Professor and stayed there till his death.

Besides his excellent research contributions in physics, cosmology and biology, Gamow wrote a number of important textbooks:

1. T*he Constitution of Atomic Nuclei and Radioactivity* (1931)
2. *Structure of Atomic Nuclei and Nuclear Transformations* (1937)
3. *Atomic Energy in Cosmic and Human Life* (1947)
4. *Theory of Atomic Nucleus and Nuclear Energy Sources* (with C. L. Critchfield, 1949)
5. *The Creation of the Universe* (1952)
6. *Matter, Earth and Sky* (1958)
7. *Physics: Foundations & Frontiers* (with John M. Cleveland, 1960)
8. *The Atom and its Nucleus* (1961)

Perhaps to many Gamow is known only as a popular science writer. His popular science writings have influenced millions in all parts of the world. His keen sense of humour is very much evident in his popular science writings. His

*Edward Teller*

books will remain as classics in the history of science popularization. Gamow is regarded as one of the most successful writers of all time. He wrote many books and most of these are still in print. Through these beautiful written books Gamow successfully conveyed much of the excitement of the revolution in physics that he lived through and other scientific topics of interest. Gamow himself prepared the illustrations for his books. Thus the illustrations added a new dimension. They complemented what he intended to convey in text. Wherever it was essential he used mathematics. The popular science books written by Gamow are listed below:

1. *Mr. Tompkins in Wonderland* (1939, it was on relativity)
2. *The Birth and Death of the Sun* (1940)
3. *The Biography of the Earth* (1941)
4. *Mr. Tompkins Explores the Atom* (1944, it was on quantum physics).
5. *One, Two, Three…Infinity: Facts and Speculations of Science* (1947, according to Gamow, the book is "...of atoms, stars, and nebulae, of entropy and genes; and whether we can bend space, and why the rockets shrinks").
6. *The Moon* (1953)
7. *Mr. Tompkins Learns the Facts of Life* (1953, it was on biology)
8. *Puzzle-Math* (1958)
9. *Biography of Physics* (1961)
10. *Gravity* (1962)
11. *A Planet Called Earth* (1963)
12. A Star Called the Sun (1964)
13. *Thirty Years that Shook Physics: The Story of Quantum Theory* (1966)
14. *Mr. Tompkins Inside Himself* (1967, This book, which is rewritten version of the *Mr. Tompkins Learns the Facts of Life*, gives broader view of biology, including recent developments in molecular biology. It was rewritten with M Ycas)

His books have been translated into many languages. In 1956 Gamow was awarded the Kalinga Prize by UNESCO—the only international award given for science popularization.

Commenting on Gamow's writings C.S.Yoganand wrote: "There have been many great scientists – I don't need to

*contd. on page....22*

# Variable Energy Cyclotron Centre, Kolkata

❑ Manas Pratim Das
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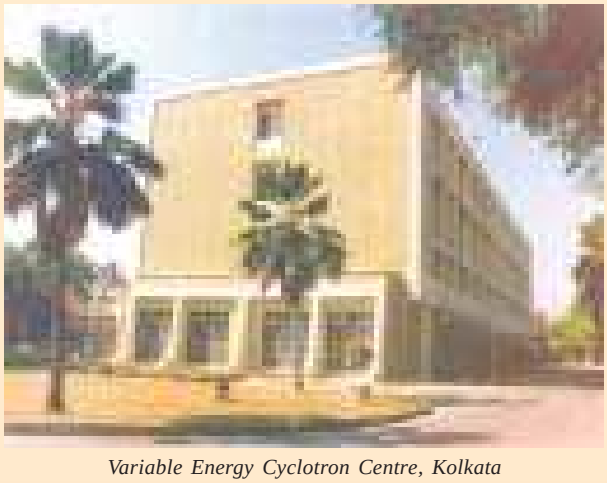
The first attempt to build a charged particle accelerator in India was started during the Second World War at the Palit Laboratory of Physics of the Calcutta University. It was a 37" fixed frequency cyclotron, modeled after the similar machine at Berkeley. After some initial problems due to technological limitations obtaining in the country at that time, it was finally commissioned in 1960. It is now decommissioned and no longer in use.

Next came the 224 cm giant Cyclotron, first of its kind in India. In fact, this cyclotron was planned way back in 1964 by the great scientist Dr. Homi Jehangir Bhaba. The sanction from the Department of Atomic Energy (DAE) came five years later, in 1969. Construction work was started in November of that year and completed in December of 1974. After putting the necessary components in place, the cyclotron became operational in June 16, 1977.



*Variable Energy Cyclotron Centre, Kolkata*

Situated at Bidhan Nagar, this cyclotron has seen a full fledged research institute build up around it over the years. It is known as the Variable Energy Cyclotron Centre or VECC, Calcutta (now Kolkata). VECC has not only established its own pride of place as a centre of excellence in the DAE family but also proved the ability of Indian scientists and technologists. VECC provides R & D support to various nuclear science programmes in addition to its own programmes of building the latest state of the art accelerator, developing technology and producing critical components required for multi-disciplinary R & D work. A wide spectrum of research and development in the areas of engineering, material science, radio chemistry, nuclear medicine, electronics, cybernetics, cryogenics, vacuum technology etc., carried out at this center is a tool for global competition.

An internationally competitive theoretical physics study on quark-gluon plasma and its cosmological significance, nuclear equation of state, the phenomenon of chaos as applicable to nucleus, multi-fragmentation in hot nuclei etc. are the current topics of interest at this centre. These efforts add to India's status among developing nations both scientifically and economically.

## MAJOR COMPONENTS OF CYCLOTRON

The cyclotron magnet weighing 262 tonnes was fabricated at Heavy Engineering Corporation Ltd., Ranchi. It provides a uniform magnetic field reaching maximum field strength of 21 kilogauss.

A large electromagnet along with epoxy- potted trim and valley coils was fabricated at Bharat Electricals Ltd., Bhopal.

Two giant 89 cm Oil Diffusion Pumps to provide high vacuum of $5 \times 10^{-6}$ torr, were fabricated at BARC, Mumbai. From the same centre came electrostatic deflector having a total arc span of 108 degrees. It extracts the circulating ion beam at full energy out of cyclotron vacuum chamber and allows it to enter the external beam lines to the experimental caves. BARC, Mumbai also supplied Large Radio Frequency (RF) mechanical structure consisting of RF panels, Dee and Dee-stem, panel drives etc.

However, the Power Electronics systems were developed mainly at VECC itself. The centre also developed an advanced Electron Cyclotron Resonance ions Source (ECRIS) for producing ions with high charged state.

## SPIN OFFs:

### *Isotope Separator on Line (ISOL) Facility*

This is an indigenously designed facility at VECC for the study of short-lived radio isotopes. This item is of great contemporary interest.

### *Radioactive Ion Beams (RIB) Project*

RIB facility is for production of secondary radioactive ion beams using the cyclotron primary beam and an upgraded ISOL system. These radioactive ion beams are useful for the study of astrophysical phenomena such as nucleo-synthesis, evolution of stars, relative abundances of elements in the universe etc.

VECC has collaborations with RIKEN accelerator facility, Japan and Saha Institute of Nuclear Physics (SINP), Kolkata in this area of research.

### *Production of Gallium Isotope (GA-67)*

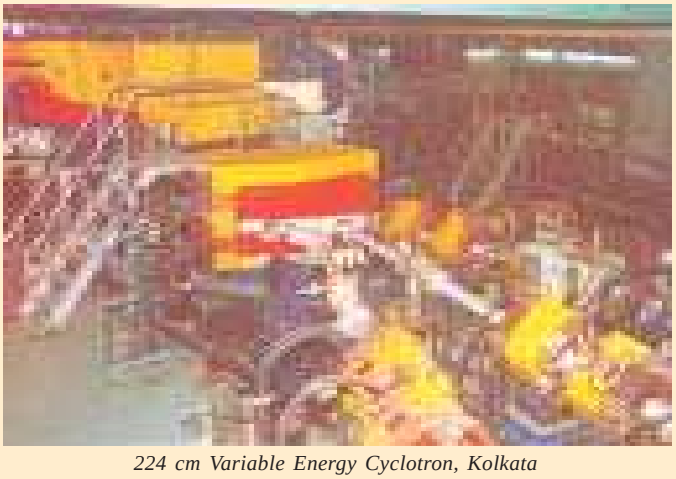
Cyclotron has produced GA-67 radio isotopes for the first time in India. It is extensively used in the diagnosis of soft tissue tumours.

### *Radiation Damages*

Simulation based studies on damages due to radiation helps in the planning of R&D activities with special reference to nuclear power industry. An added area of research is material science and radiation biology.

### *Nuclear Medicine*

VECC has set up a Regional Radiation Medicine Centre (RRMC) at Thakurpukur, in collaboration with the Cancer



*224 cm Variable Energy Cyclotron, Kolkata*

Centre Welfare Home. This centre utilizes Gamma Cameras and Radio Immuno Assay (RIA) for diagnostic purposes and 4 Mev Medical Linear Accelerator (LINAC) for cancer therapy. The RRMC is a solace for cancer patients in the Eastern and North Eastern and North Eastern Regions of India.

### *Helium Recovery*

VECC scientists have developed a innovative process to recover naturally occurring helium gas from the hot spring at Bakreswar, West Bengal. Helium finds application in high technology areas such as Super conducting magnet which is an integral part of Super conducting cyclotron.

### SUPERCONDUCTING CYCLOTRON

VECC has undertaken the design & construction of a liquid helium cooled super conducting cyclotron. When completed, its operation will extend the maximum available energy from 30 MeV / nucleon (from 224 cm cyclotron) to 200 MeV/ nucleon (from Super conducting cyclotron)which is well above the Fermi energy and also more than the velocity of sound in nuclear matter.Thus, this machine will provide excellent means for the understanding of complex phenomena like compression of nuclear matter, hydrodynamical flow, multi-fragmentation & creation of hot and dense hadronic matter etc.

The Superconducting cyclotron will usher in a new era in experimental nuclear science and technology facilitating a quantum leap towards the frontiers of basic and applied research—at par the contemporary international scenario. Apart from utility in basic science, it will find application in diverse fields like cryogenic technology, radiation damage studies related to reactor materials, proton and heavy ion induced therapy etc. There are only few such machines in the world.

### *International Collaboration*

The centre is a leading contributor to the international efforts on the search for Quark Gluon Plasma(QGP). This research will give us an idea of the state which existed in the early universe, a microsecond after the Big Bang. In fact, through

## Accelerators of Charged Particles

Charged particle accelerators have played the most crucial role in the development of nuclear physics. Before the advent of these machines, the only sources of high-energy charged particles required for the study of nuclear transmutation were the naturally radioactive substances emitting alpha and beta particles. However, the usefulness of these sources for such studies is very limited due to the limitations both of energy and of the intensity of the beam of particles.

Lord Rutherford, who carried out the pioneering experiment on the artificial transmutation of elements, realized these limitations. So he urged his students J.D. Cockroft and E.T.S. Walton, to build a particle accelerator which would accelerate protons to high enough energy to produce nuclear transmutation.

At his suggestion, Cockroft and Walton built a high voltage generator, based on the principle of voltage multiplication, first proposed by H. Greinacher (1921). With this machine they were the first to produce nuclear transmutation with artificially accelerated charged projectiles (protons)and produced the disintegration of the lithium (7Li) nucleus into two alpha -particles, using protons of 770 KeV energy.

### Classification and performance characteristics of accelerators

Accelerators can be divided broadly into two classes. To the first class belong the electrostatic accelerators in which the charged particles are accelerated by applying a constant voltage difference between the ion source and the target. The value of this voltage difference determines the final energy of the particles. The Cockroft - Walton and the Van de Graaff generators belong to this class. The acceleration of the charged particles in electrostatic accelerators takes place in one step.

The main limitation of these machines is the voltage breakdown due to discharge between the high voltage (HV) terminal and the walls of the accelerator chamber for potential difference greater than about a million volts. So these accelerators can accelerate the particles only a few million electron volts (MeV).

The second class of machines, known as cyclic accelerators, accelerate the particles in multiple steps, imparting a relatively small amount of energy at each successive step. The trajectory of the particles in these machines can be curved as in the cyclotron, betatron, synchro-cyclotron and synchrotron or straight as in the linear accelerator. The acceleration at the successive steps takes place either by the repeated application of a properly phased time varying electric field or by time varying magnetic induction.

The performance index of the accelerators is determined by the following considerations:

a) Maximum energy attainable
b) Beam intensity
c) Homogeneity of the particle energy (i.e. whether the particles incident on the target have any energy spread);
d) Energy stability
e) Collimation of the beam;
f) Nature of the accelerated particles;
g) Continuous or pulsed operation

*Saha Institute of Nuclear Physics, Kolkata*

this research, scientists are trying to create a mini - bang in a laboratory and hoping to study the mystery of the creation of the universe.

VECC, leading the group with several other Indian organizations, has made impressive progress on the development Photon Multiplicity Detector (PMD) as a major component of the integrated detector ALICE for the Large Hadron Collider (LHC) under construction CERN, Geneva. More recently PMD is also being planned to be used at the STAR detector to be used at Relativistic Heavy Ion Colllider (RHIC) at Brookhaven National Laboratory, USA. The STAR PMD project is making good progress.

Variable Energy Cyclotron Centre, Kolkata is undoubtedly a centre of excellence in nuclear research in India . However, its team of dedicated scientists & engineers realize that there is no room for complacence. Hence, they are striving harder to attain new heights. Tomorrow, surely belongs to them.

**Manas Pratim Das**, 52/1, Netaji Subhash Road, P.O. New Barrackpore, Distt.-24 Paraganas (N) West Bengal

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## Interview with Director, Dr. Bikash Sinha

**Manas :** What have been the strong point of VECC?

**Dr. Sinha :** Firstly, the technology associated with the cyclotron. The cyclotron commissioned in the late seventies is still running excellently. Here, we have a wonderful mix of good order Physics & technology. The Radioactive Ion Beam Project, Helium Ion Project at Bakreswar, Medical Cyclotron for which the Government has given money—all these make us proud. Research in collaboration with CERN should also be mentioned in this regard.

**Manas :** What is its weakness?

**Dr. Sinha :** Well, here in VECC, the work output is still not commensurate with the quality of manpower. The quality of scientists & engineers is superb but the output leaves a lot to be desired.

**Manas :** We are aware that fund crunch is affecting research in various institutions in India. What is your opinion regarding this issue?

**Dr. Sinha :** We try to ape the USA in science & technology research. But, as far as investment in science & technology is concerned USA has reached the stage of criticality. They spend ten to twelve percent of GNP towards research. We spend just 1.8% of GNP. Clearly, we need to spend more otherwise the future would not be bright for Indian science.

**Manas :** Where do you see VECC, ten years from now ?

**Dr. Sinha :** Accelerator technology has still not taken roots in the country. It is not designed here. With time, indigenous technology may come up in the country. However, I don't believe that in this age of globalization, every equipment needs to be manufactured in the country.

As far as expansion of VECC is concerned, we need more land for constructing big centers for particle accelerators and allied science. I strongly believe we will be able to keep up the combination of research in fundamental Physics at SINP and technology at VECC and improve on it in the future.

**Manas :** What is your message to budding scientists?

**Dr. Sinha :** I want to tell them that the satisfaction in doing science is sublime. Along with that, the little help that is provided in nation building, is of great importance. Those who really want to do scientific research, should make their own judgment and not bow down to parental and societal pressure.

**Interviewed by: Manas Pratim Das**

***VP News (EDUSAT...) Contd. from page 36***

To invite ideas for the science channel from the Departments/ Ministries engaged in scientific activities, a meeting was organized on August 02, 2004 at India International Center, New Delhi. Besides representatives from Departments/ Ministries engaged on scientific activities, a few individuals associated since the beginning of the project were also invited. Shri Kapil Sibal, Hon'ble Minister of State for Science and Technology and Ocean Development (Independent Charge) chaired the meeting. Among others were present in the meeting included Prof. V.S. Ramamurthy, Secretary, DST, Dr. Harsh Gupta, Secretary DOD, Dr. M.K. Bhan, Secretary, DBT, Prof. Yash Pal, Prof. E.V. Chitnis, Shri Bhaskaranarayanan, ISRO, Hqrs. Shri B.S. Bhatia, Director, DECU and Dr. V.B. Kamble, Director, Vigyan Prasar.

# Mercury—Closest Planet to the Sun

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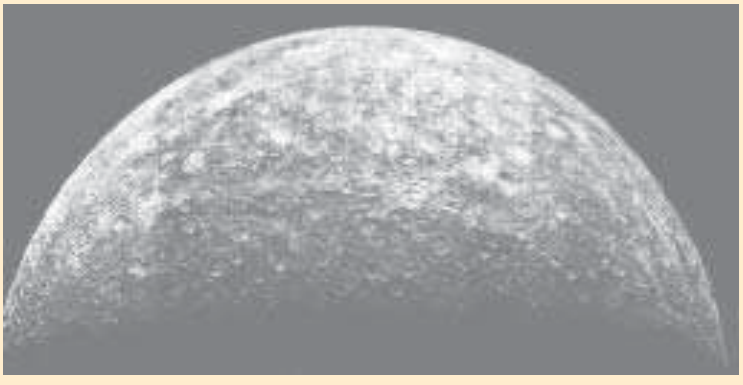


Any curious person goes away far from city lights and looking at night sky will encounter with verity of objects twinkling and shining in the sky. We are not interested in each twinkling objects but the brightest objects named planets (this is not be true for all the planets, we will see in future). With little idea of the location in the sky will show you the position of planets. Here we are starting a series of articles on planets where we will see each planet in more details with respect of its history, position, composition, external features and their satellites (if it has) etc.

Our solar system consists of Sun, inner planets and outer planets. In more specific words the inner planets consists of Mercury, Venus, Earth and Mars while outer planets consists of Jupiter, Saturn, Uranus, Neptune and Pluto. The newly discovered object 'VB-10' or 'Sedena' will be of more interest to all of us which will be discussed in more details in future article. If at all we have talk of the mass distribution of the solar system then 99.85 % of mass is governed by our Sun and remaining is with all the planets. Every planet is revolving in elliptical orbit with Sun at its foci (focus) point, and also revolves round its axis perpendicular to elliptical plane. We are not going into the details of how the solar system is formed because it is of great controversy till date and it is governed by many scenarios and hypotheses. We will start our series with the first planet and will proceed further.

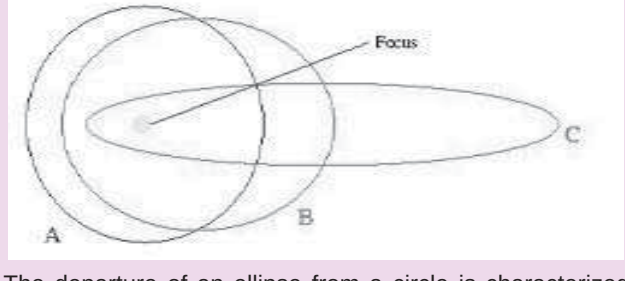
If we start our journey to the planets right from the Sun then we will first encounter to the planet named 'Mercury'. In Roman mythology 'Mercury' is the God of Commerce while Greek says it is the Messenger of God. The probable reason for this could be because it moves fast in the sky. In Hindu mythology, according to Vishnu puran Mercury is known as grahapati named as BUDHA, son of moon. Vedic sage Parasara describes; "Mercury is endowed with an attractive physique and the capacity to use words with many meanings". Mercury is the innermost planet in the solar system, hence its orbit is very near to the Sun with most elliptical orbit among all the planets except Pluto. Mercury has an eccentricity value of 0.2056 (see Box A for details), at perihelion it is about 46 million km and at aphelion it is about 70 million km away from the Sun. The average distance is about the 57 million kilometers from the Sun. This is the first **terrestrial*** planet in the solar system. The detailed profile for this planet is shown in Box-B.

Mercury is sometimes visible near the horizon in the evening sky just after sunset or in the dawn sky just before sunrise. Earth-based telescope shows that Mercury is passing through phases like the Moon of Earth. Whatever we know about the surface of Mercury is based on photographs and measurements taken by the Mariner 10. This is the only spacecraft visited to the Mercury in 1974-75 at the distance of 48,069 km from the Mercury and had been able to map only 45% of surface detail.

In 1880, Italian astronomer Giovanni Schiaparelli sketched the faint features of the Mercury and concluded that the planet is tidally coupled to the Sun like our Moon is coupled to Earth. In a sense, that the same face of Mercury is directed towards Sun all the time with the conclusion that the day and year of the planet is same.

**BOX - A**

To construct an ellipse you first need two points, called foci. An ellipse is every point such that the sum of the distances between both foci at each point on the ellipse is constant. Below are some examples of ellipses.




The departure of an ellipse from a circle is characterized by its ellipticity, denoted as *e*. Ellipses has an ellipticity between 0 and 1. Circles have an ellipticity of 0 and parabolas have an ellipticity of 1. In the Figure about A shows an ellipse with $e = 0$ (therefore it is a circle), B is an ellipse with $e = 0.2$ this is how the orbit of Mercury could look like, and C is an ellipse with an ellipticity $e = 0.7$. It is a major mathematical and conceptual achievement that Kepler was able to take Tycho Brahe's observations and determine that the planets obeyed these laws to the high precision of the data.

** The planet having surface as a land is called terrestrial planet.*

**Box - B**
**Profile of Planet Mercury**

| | |
|---|---|
| Average distance from the Sun | $5.79 \times 10^7$ km |
| Eccentricity of Orbit | 0.2056 |
| Maximum distance from the Sun | $6.97 \times 10^7$ km |
| Minimum distance form the Sun | $4.59 \times 10^7$ km |
| Inclination of the orbit to ecliptic | $7^0\ 00'\ 16''$ |
| Average orbital velocity | 47.9 km/sec |
| Orbital period | 87.969 days |
| Period of rotation | 58.646 days |
| Inclination of equator to orbit | $0^0$ |
| Equatorial diameter | 4878 km |
| Mass | $3.31 \times 10^{23}$ kg |
| Average density | 5.44 g/cm$^3$ |
| Surface gravity | 3.724 m/sec$^2$ (0.38 % of earth) |
| Escape velocity | 4.3 km/sec |
| Surface temperature | $-173^0$ to $330^0$ C |
| Average albedo | 0.1 |

This was the impression till 1962. In 1965 radio astronomers showed that this assumption was false, they used 305 meter Arecibo dish to transmit a pulse of radio wave at Mercury and they found Doppler shift (see Box C for details) in the reflected radio wave which helped to conclude that the period of rotation is 59 days while orbital period is 88 days which is very higher than the length of day of Mercury. Hence it is known that the Mercury rotates thrice in two of its years.

It is worth to mention here that it has been observed that the precession of elliptical orbit of Mercury is faster than predicted by Newton's law that afterwards justified by Einstein's theory of general relativity (explained in Box D). Henceforth the orbital motion of Mercury is taken as conformation of the curvature of space-time as predicted by general relativity.

Surface temperatures of Mercury are most extreme in the solar system, it ranges from $400^0$ C in daytime to the $-180^0$ C in night. In many respect planet Mercury is very similar to our Earth's moon. Its surface is heavily cratered with all sizes of craters including some large basins. Some of the craters are old and degraded while some of them are quite young with bright ejecta (material thrown out by volcano). One of the largest features on Mercury's surface is Caloris Basin as shown in Figure 1, this is the photograph taken by Mariner 10 where half of the portion is only visible while half was in the shadow.

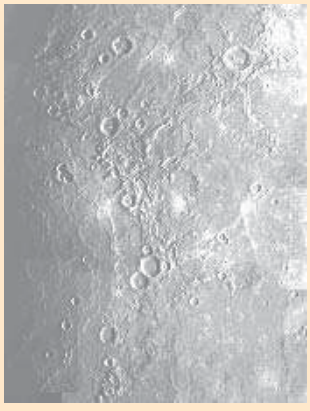


*Figure 1: This is the biggest feature named Caloris Basin present on the surface of Mercury.*

Caloris Basin is about 1300 km in diameter with concentric mountain rings up to 3 km high. It is thought to be similar to the large basins like Maria on the moon. It was probably caused by a very large impact early in the history of solar system. This Caloris Basin is partially filled with lava flows, some of this lava may be a material melted by the impacts. This impact could also be responsible for the odd terrain on the exact opposite side of the planet as shown in Figure 2.

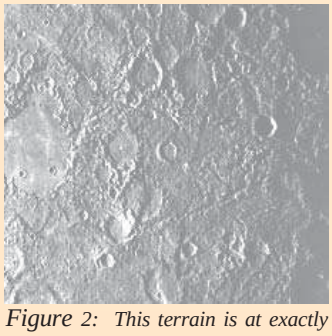


*Figure 2: This terrain is at exactly opposite side of planet that could be formed after a great impact for the formation of Caloris Basin.*

The detailed study of Mariner 10's photographs helped planetary scientists to locate something different than the Moon's surface marked by great curved cliffs called 'lobate scarps' as shown in

**BOX – C**

In 1842, *Christian Doppler* noted an apparent change in the observed wavelength of a signal from the source (sound wave) as a result of motion either towards or away from an observer. This change in the wavelength is called D*oppler shift*.

This Doppler effect is applied to all wave-like phenomena *e.g. electromagnetic (EM) waves and sound waves.* The famous everyday example could be the sound of siren from emergency response vehicle. The pitch increases as vehicle approaches to you and decreases as it moves away from you.

Here we will see this *Doppler formula* for electromagnetic waves.

If a source emits EM waves at wavelength $\lambda$, then the apparent change in wavelength $(\lambda_{obs} - \lambda)$ will be given by,

$$(\lambda_{obs} - \lambda) / \lambda = V/c$$

where $\lambda_{obs}$ is the observed wavelength, V is relative velocity in line of sight (radial velocity) and c is velocity of light ( $3 \times 10^8$ m/ sec).

In case of Mercury, we can get the value of V from above equation and after substituting this value in the equation of rotation period we can easily get the value of orbital period (length of the day) of Mercury as shown below:

*Radio astronomers with the help of 305 meter Arecibo dish used the radio waves of the wavelength ($\lambda$) 0.5 meter and measured the reflected apparent change in wavelength ($\lambda_{obs} - \lambda$) as $5.0 \times 10^{-9}$ meter. And henceforth used the Doppler formula* rewritten as,

$$V_{rad} = c\,(\lambda_{obs} - \lambda) / \lambda$$

$$\therefore V_{rad} = 3 \times 10^8\,(5.0 \times 10^{-9}) / 0.5$$

$$\therefore V_{rad} = 3 \text{ meter/sec}$$

The period of rotation is give by,

$$P = 2\pi R_{\mercury} / V_{rad}$$

where $R_{\mercury}$ is the radius of planet Mercury,

$$\therefore P = 2 \times 3.14 \times 2440 \times 10^3 / 3$$

$$\therefore P = 5.107 \times 10^6 \text{ sec}$$

$$\therefore P \cong 59 \text{ days}$$

P = 2/3 its orbital period

It proves that Mercury spins three times on its axis for every two of its orbits round the Sun.

Figure 3. This lobate scarp is about 350 kilometers long and transects two craters 35 and 55 kilometers in diameter. The maximum height of the scarp south of the 55-kilometer crater is about 3 kilometers. This could have formed when the planet cooled and shrunk by a few kilometers. In addition to this, there are some regions, which are smooth plains. These are may be the result of ancient volcanic activity and some of them could be the deposition of ejecta from cratering impacts, which are shown in Figure 4.

*Figure* 3: One of the most prominent lobate scarps (Discovery Scarp), photographed by Mariner 10 during it's first encounter with Mercury, is located at the center of this image shown by the arrow (extending from the top to near

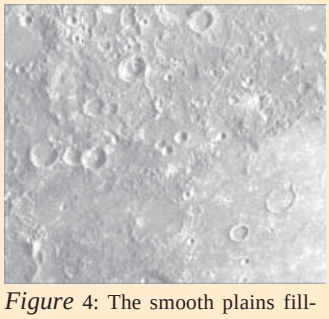


*Figure* 4: The smooth plains filling this 440 kilometer basin centered at 15 degrees S, 149 degrees W of Mercury. This is formed by volcanic activities on the Mercury.

A reanalysis of the Mariner data provides some preliminary evidence of recent volcanism on Mercury. But more data will be needed for confirmation

Mercury is much denser than the Moon (5.43 gm/cm$^3$ to 3.34 gm/cm$^3$ of moon) and has only a relatively thin silicate mantle and crust. This outer shell (crust and mentle) of silicate is of only 500 to 600 km in thick as compaired to earth of 2900 km. The actual interior is dominated by a large iron core which could be of 1800 to 1900 km in radius.

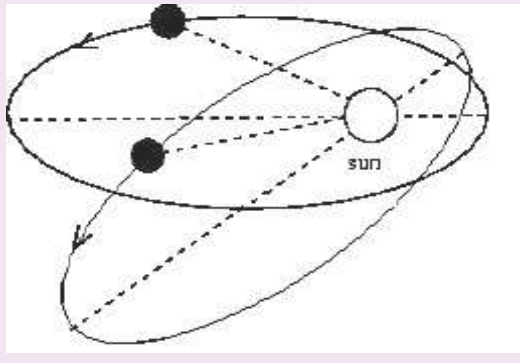
Mercury do have very thin atmosphere consisting of atoms blasted off its surface by the solar wind. Since the Mercury is so hot, these atoms quickly escape into space. Thus in contrast to the Earth whose atmosphere is stable, Mercury's atmosphere is constantly being replenished. The rough estimates about the consituents' content in the Mercury's atmosphere is, 31.7% of Potassium, 24.9% of Sodium, 9.5% Oxygen and 7% Argon.

To our surprise, radar observations of Mercury's north pole (could not mapped by Mariner 10) show the evidence of water ice in the protected shadows of some craters.

**BOX - D**

Newton's Law of Universal Gravitation gave the wrong prediction for the precession of the perihelion of Mercury's orbit. Mercury's orbit is elliptical, as predicted by Newton's theory of gravity, but the ellipse doesn't stay in precisely the same place all the time. It precesses, which is to say that as Mercury orbits the sun, the entire ellipse rotates about the focal point (i.e. the sun) as shown in the Figure below. This precession is very small, only 570 seconds of arc per century. A second of arc is 1/360 of a degree. Most of this precession could be understood in the context of Newton's theory of gravity by taking into account perturbations of the orbit due to the presence of other planets. However, once this was done, there still remained a discrepancy of about 43 seconds of arc per century between the prediction, and the observed value. This discrepancy was a complete mystery to the scientists. They even went as far as postulating the existence of an unseen planet (Vulcan) on the far side of the Sun in order to explain it, but could not succeed.

It was not until Einstein published his work on the general theory of relativity that the perihelion shift of Mercury was truly understood.




As the closest planet to the Sun, Mercury orbits a region in the solar system where space-time is disturbed by the Sun's mass. Mercury's elliptical path around the Sun shifts slightly with each orbit such that its closest point to the Sun (or "perihelion") shifts forward with each pass. And finally this missing 43-second of arc was matched with observations as per Einstein's predictions.

Mercury do have magnetic field but the value is just about the 1% of the Earth.

Mercury has no known satellite.

***Arvind C. Ranade has recently joined Vigyan Prasar as Senior Scientific Officer**

## Messenger heading for Mercury

We have seen in the article that *Mariner 10* was the only spacecraft visited to Mercury in 1974-75. And only 45% of the surface details are known to us, but still there are many unanswered questions about the planet like mystery of its magnetic field, availability of water on the surface etc.

It has been reported that National Aeronotics Space Agency (NASA), USA will launch a new mission to Planet Mercury named '*MESSENGER' on August 2, 2004*. MESSENGER is a short form of MErcury Surface, Space, ENvironment GEochemistory and Ranging. This is also the name of planet Mercury in Roman mythology, as we have seen in the article.

Important aspect of MESSENGER will be to operate behind a ceramic heat shield to keep its instrument at room temperature and will pass only briefly over the hotter equatorial regions in order to limit exposure to heat reflected from the surface of the planet. The scientific equipment on board includes an instrument for measuring magnetic fields, and a battery of spectrometers for probing the chemistry of the planet. This time around there will be cameras taking panoramic full colour pictures of the entire planet.

# Cholesterol: The Good, the Bad, the Ugly

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Thanks to the aggressive ad campaigns run by the manufacturers of so-called healthy cooking oils, everybody seems to know about cholesterol. A waxy, fatty substance carried in the blood, it poses serious risk if we have too much of it. Medical researchers have found that if we let its levels run high, its deposits can build up on the walls of our arteries. The process is called *atherosclerosis*. It carries with it a serious threat of angina, heart attack and cerebral stroke. But before we go into more details, let us get our basics right.

## Why We Need Cholesterol

The strange fact is that even though cholesterol is often talked about as if it were a poison, we cannot do without it. It is in every cell of our body, and every cell needs it. It is indispensable to our body's cell membranes, to the insulation of our nerves and to the production of certain hormones. The hormones that help us tackle stress—cortisol, and those that keep our sex lives riveting take shape from cholesterol. It is also a component of the bile juice and helps us digest food.

## Sources of Cholesterol

It may surprise you, but the hard fact is that about 80 per cent of the cholesterol in our body is indigenously produced. It is the liver that makes it. The rest comes directly from the food we eat. Only animal products, such as meats, eggs, and dairy foods, including milk, cream and butter contain cholesterol. Foods of plant origin do not contain any of it. The arithmetic and percentages, therefore, may change for true vegetarians who shun foods of animal origin *in toto*, but since a large percent of cholesterol emanates from the chemical factory of the liver nobody can think that he or she is doing well on the 'cholesterol arithmetic' unless they take a check.

## Forms of Cholesterol in the Blood

Like other nutrients from digested food, cholesterol is transported throughout our body by our bloodstream. For this to happen, our body coats cholesterol with a protein. The cholesterol-protein package is called a 'lipoprotein'.

These lipoproteins are also of several kinds. Based on their chemical structure, densities, and effect they are named as very low-density lipoprotein (VLDL), low-density lipoprotein (LDL), and high-density lipoprotein (HDL). The first two, VLDL and LDL are often referred to as 'bad' cholesterol. They also have a close cousin in triglycerides. Over time, they can build up in our blood vessels and form a plaque. In contrast, high-density lipoprotein (HDL) cholesterol is often called 'good' cholesterol because it helps scavenge or 'clean' cholesterol from our blood vessels.

Medical biochemists have found ways to measure each of these forms of cholesterol. The test goes by the name of 'lipid profile' and the blood sample for it must always be given after fasting for at least 12 hours.

**Understanding Your Lipid Profile Test**

| Test | Desirable mg/decilitre | Borderline mg/ decilitre | Undesirable mg/decilitre |
|---|---|---|---|
| *Total cholesterol* | Below 180 | 180-240 | Above 240 |
| *LDL cholesterol* | Below 100 | 100-150 | Above 150 |
| *Triglycerides* | Below 150 | 150-400 | Above 400 |
| *HDL cholesterol* | Above 45 | 35-45 | Below 35 |

## Health Consequences

The risk of skewed cholesterol or lipid profile is most serious for the arteries of small and medium size. Once cholesterol deposits on their walls, the inside diameter of the arteries shrinks and this reduces the flow of blood through them. The fat plaques also roughen the narrowed arteries, and this can spur the formation of a clot, which by lodging into a narrow segment can cause a sudden and complete block of blood flow in the area. If this catastrophe occurs in any of the coronary arteries, it causes a heart attack. In the brain, the same process leads to a cerebral stroke. But even without a clot, the very reduction of blood flow can lead to a number of clinical conditions. Coronary artery disease is the most serious among them, and it presents as angina. The disease can also affect the arteries that feed the legs, causing pain on walking or angina of the legs! In a male, it may also cause impotence.

**Simple Mantras to Cut down Your Risk**

A number of lifestyle measures, including a low-fat diet, regular exercise, weight loss, and other changes can help bring your 'bad' cholesterol down and cut down the risk for cardiovascular disease. Let us take a closer look at these simple mantras:

**Eat less :** If you are serious about cutting down the ugly fat and flab, watch your calories. All excess calories, in whichever form you take, are turned into bad cholesterol and triglycerides by the liver.

**Curtail dairy fats :** Dairy products are high on 'hard' or saturated animal fats. Butter, *malai*, desi ghee, and cheese are the worst culprits. They should be limited to 10 per cent or less of total calories. For those who enjoy milk and other dairy products, shifting to the double toned or fat-free variety is the best way out.

**Turn into a veggie :** Vegetarians have a much lower risk of a disturbed lipid profile. Besides the obvious elimination of saturated animal fats, a vegetarian diet adds fibre, vitamins, minerals, and polyunsaturated fatty acids. That's healthier and more wholesome.

If you wish to enjoy the non-vegetarian food, try fish. It contains the healthy omega-3 fatty acids and is protective for the heart.

**Take plenty of fibre :** Water-soluble fibre, found in whole fruits, green leafy vegetables, oat bran, psyllium seed, legumes, whole grains and pectin, binds with cholesterol in the intestines and causes excretion of

cholesterol from the body. Not only does this lower our LDL levels but also leads to a healthy increase in the HDL levels. That's one more reason to turn into a vegetarian.

**Use a healthy cooking medium :** Poly- and monounsaturated vegetable oils can help reduce the bad cholesterol, and also triglycerides. Oils high on this virtue include the safflower, sunflower, wheat germ, corn, canola, and mustard oil. You can use a mix of these or use them by turn to add to variety and health. But the best course is to use less and less of oil and instead of frying, steam, bake or grill food. The current dietary guideline is that polyunsaturated and monounsaturated fats should constitute no more than 30 per cent of your total calories per day.

Vanaspati ghee, or hydrogenated oil must be avoided altogether. It has the trans fatty acids which increases the LDL or the bad cholesterol. Coconut and palm oil and *desi* ghee are also passé.

**Use alliums :** Some foods lower bad cholesterol, reduce triglycerides, cause a rise in HDL, and reduce the clumping of platelets. Ginger, onion and garlic—all members of the allium family enjoy the best reputation in this regard. They may also help in keeping he blood pressure under check.

**Too much of sugar is bad :** Desserts and table sugar by the sheer load of their calories can burden you with high cholesterol and triglycerides. Give your "sugary" tooth a rest.

**Take salad and fruits for snacks :** If you enjoy snacking in between meals, keep off dal bhujiya, mathi, samosas, bread pakora, patties, and cakes and pastries. Instead, try salad and fresh fruits.

**Natural vitamins and minerals are useful :** Foods that are naturally rich in vitamins C, E, $B_6$, niacin, magnesium, calcium, zinc, copper, chromium, selenium, carnitine and lecithin may be useful for your circulation. Studies suggest that they all may play a role in decreasing the risk of fatty plaque formation in the arteries.

**Never take a peg more :** Even though tipplers may believe that alcohol is good for the heart, it is clear that alcohol in excess causes a rise in triglycerides. Only up to 60 ml of alcohol a day can be admitted as safe.

**Take regular exercise :** The best and the simplest way to bring things under control, is to do regular exercise. Just 30 minutes of aerobic exercise, like brisk walking, cycling, jogging or swimming daily or four or five times a week would lower the bad cholesterol and improve the good HDL fraction. Exercise also offers several other benefits: it reduces stress (another risk factor for cardiovascular disease), strengthens muscles and bones, adds to cardiac and respiratory reserve and improves immunity and well-being.

**Medication :** Sometimes, lifestyle measures are not enough. The cholesterol level may still put you at risk of heart attack or stroke. Fortunately, there is now an array of powerful medicines available that can rapidly reduce your cholesterol and, ultimately, the health risks it poses. They, along with lifestyle changes, are often recommended for people without established cardiovascular disease if:

- Your LDL cholesterol is more than 190 mg/dL after lifestyle changes, or
- Your LDL cholesterol is more than 160 mg/dL after lifestyle changes and you have two or more risk factors for cardiovascular disease.

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# An Encounter with Saturn

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After a nearly seven-year long arduous journey, Cassini, spacecraft launched to study Saturn and its system enter orbit around Saturn on June 30, 2004. Launched on Oct. 15, 1997, on a journey covering 3.5 billion kilometers, Cassini is the most highly instrumented and scientifically capable planetary spacecraft ever flown. The mission was an international one with participation from NASA, European Space Agency (ESA), Italian space agency Agenzia SpazialeItaliana (ASI) among others. In total 17 countries were involved in the design, launch and control of the spacecraft.

The Cassini-Huygens mission is a four-year study of Saturn. There are 12 instruments on the Cassini orbiter and six more on the Huygens probe. These 18 highly sophisticated science instruments will study Saturn's rings, icy satellites, magnetosphere and Titan, the planet's largest moon. Cassini will pass through a gap between two of Saturn's rings, called the F and G rings. Cassini will swing close to the planet and begin the first of 76 orbits around the Saturn system. During Cassini's four-year mission, it will execute 52 close encounters with seven of Saturn's 31 known moons.

*Figure 1: Cassini and Huygens*

Just as Kangaroo carries the baby in its pouch, a small spacecraft named Huygenes ride Piggyback on Cassini spacecraft. On Dec. 25, 2004 Cassini will release the Huygens probe on its journey toward Titan, largest moon of Satrun. Huygens will be the first probe to descend to the surface of a moon of another planet. It will also make the most distant descent by a robotic probe ever attempted on another object in the solar system. On Jan. 14, 2005, after a 20-day ballistic freefall, Huygens will enter Titan's atmosphere. It will deploy parachutes and begin 2.5 hours of intensive scientific observations. The Huygens probe it is expected would transmit data to the Cassini spacecraft, which will relay the information back to Earth.

## Saturn

Saturn is the sixth planet from the sun. It is the second largest planet in our solar system, after Jupiter. One of five "naked eye" planets known to the ancients. Saturn is named for the Roman god of agriculture, also linked to Kronos, Greek god of time, father of Jupiter and king of the gods. In Hindu mythology Saturn is called Sani and revered as Sanishwar. One story about the origins of Ganesh, the Hindu god with an elephant's head, says Sani burnt his original head to ashes with his glance and this had to be replaced with the first thing found.

Saturn is the second largest planet in the solar system, after Jupiter. Equatorial diameter 120,536 kilometers at cloud tops; polar diameter 108,728 kilometers (67,560 miles), making it the most oblate (flattened) planet. It is so big that if we consider the Saturn as a big bag and Earth as apples; we can fill the Saturn bag with 764 Earth- apples! Nonetheless it is only 95 times more massive than Earth. Amazingly the density is 0.69 (while that of water = 1), the least dense planet and the only one lighter than water. This implies if we find an ocean large enough then Saturn would float on the surface of the ocean. It is supposed that the chemical composition of the planet, which is primarily hydrogen and helium, accounts for its low density.

## Saturn's Ring system

The most prominent feature of Satrun is its Ring system. When it was first observed by Galileo Galilee, it appeared to him as if Satrun has two ears on its both sides (or like handle of tea cup on both sides). This was amazing and perplexing for Galileo as well as contemporary astronomers. Further investigations showed that actually what appeared like 'ears' were actually ring like structure orbiting around Saturn. Saturn's main ring system would barely fit in the space between Earth and its Moon and they are named alphabetical in order of their discovery. "Cassini Division" between the B ring and A ring is sparsely populated with ring material, is so named for it was first observed by Cassini, an Italian astronomer; and the spacecraft is also named after him.

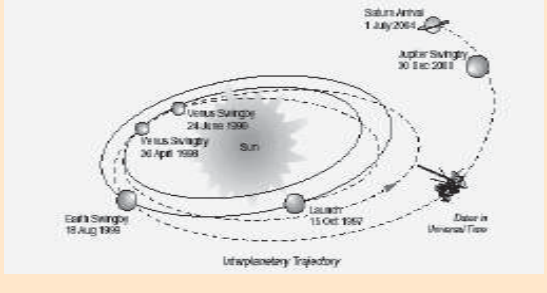


*Figure 2: The Trajectory of the space mission*

Satrun has been explored by space missions earlier. The Pioneer 11 flyby September 1, 1979, the Voyager 1 flyby mission of November 12, 1980 and the Voyager 2 flyby mission August 25, 1981 provided us with startling information. Yet, the Cassini- Huygens mission is poised to unravel many mysteries.

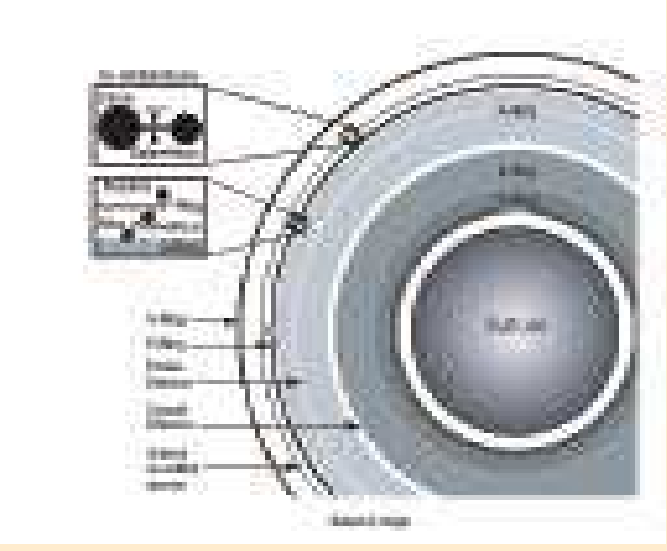

*Figure 3: The Ring system*

## The scientific objectives of the mission

Saturn offers a rich scientific environment to explore. While the other giant planets, Jupiter, Uranus, and Neptune, have rings, the rings of Saturn are unique in the solar system in their extent and brightness. They are the signature feature by which Saturn is known. The planet and ring system serve as a miniature model for the disc of gas and dust surrounding the early sun that formed the planets. Detailed knowledge of the dynamics of interactions among Saturn's elaborate rings and numerous moons, it is anticipated, will provide valuable data for understanding how each of the solar system's planets evolved. The success of searches for other planetary systems elsewhere in our galaxy partly depends upon how well we understand the early stages of formation of planets.

Detailed knowledge of the history and processes now occurring on Saturn's elaborately different moons may provide valuable data to help understand how each of the solar system's planets evolved to their present states. Represented among Saturn's collection of moons is a huge variety of chemical, geologic and atmospheric processes.

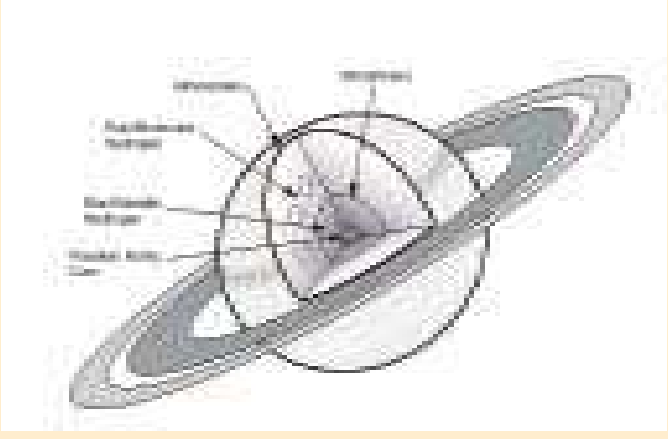

*Figure 4: Saturn*

Chief among Cassini's goals within Saturn's system is the unmasking of Titan. This is of importance too. Titan may preserve, in deep-freeze, many of the chemical compounds that preceded life on Earth. Titan is the only moon in the solar system that possesses a dense atmosphere (1.5 times denser than Earth's). The fact that this atmosphere is rich in organic material and that living organisms as we know them are composed of organic material is particularly intriguing. ("Organic" means only that the material is carbon-based, and does not necessarily imply any connection to living organisms.) Cassini will execute 45 flybys of Titan, coming as close as approximately 950 kilometers above the surface. This will permit high-resolution mapping of the moon's surface with an imaging radar instrument, which can see through the opaque haze of Titan's upper atmosphere. Scientists hope that the hazy moon- Titan- may hold clues to how the primitive Earth evolved into a life-bearing planet.

Astrologers claim, albeit without any rational ground that gaze of Saturn would afflict us with misfortune; nonetheless, it is clear that our scientific gaze at Saturn, would result in deeper understanding of universe and progress of scientific knowledge.

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*(Groge...) Contd. from page 32*

give examples! – and many popular science writers – Isaac Asimov's is perhaps one of the names that comes to mind immediately. But Gamow belong to that rare species of first class scientists who are also first class science communicators. It is hard to name another from the same species... A distinguishing feature of Gamow's writings, indeed of his life itself, is universality. They represent science as a whole. Importantly, he does not avoid mathematics if and when necessary unlike most of the 'popular science writers".

*Abbe Georges Edouards Lemaitre*

Gamow died on August 19, 1968. After his death, his wife and the Physics Department of the University of Colorado started the George Gamow Lecture series.

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# Francis Crick: A Tribute

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Nobel Prize-winning scientist Francis Harry Compton Crick, who co-discovered the spiral, "double-helix" structure of DNA in 1953. This discovery ushered in an era of biomedical revolution. Crick, died on 29th July 2004, at a hospital in San Diego, California. He had been suffering from colon cancer. Crick is credited with a number of important discoveries but will best be remembered for determining the omnipresent structure of deoxyribonucleic acid (DNA). The discovery of the three-dimensional molecular structure of the DNA is of great importance, because, it outlines the possibilities for an understanding in its finest details of the molecular configuration, which dictates the general and individual properties of living matter. The 1962 Nobel Prize for Physiology or Medicine was awarded jointly to Francis Crick, James Dewey Watson and Maurice Hugh Frederick Wilkins, for their discoveries concerning the molecular structure of nucleic acids and its significance for information transfer in living material.

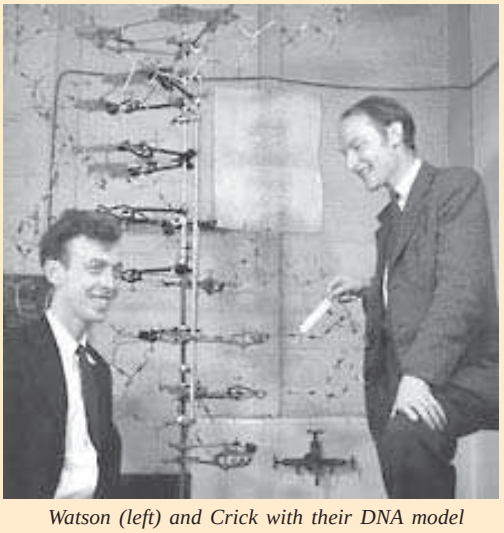
*Francis Harry Compton Crick*

Francis Crick was 88. He is survived by his wife, artist Odile Speed; three children; and four grandchildren. The Crick family lived in a house appropriately called "The Golden Helix". Scientists around the world have paid rich tribute to Crick. "I will always remember Francis for his extraordinarily focused intelligence and for the many ways he showed me kindness and developed my self-confidence," said James Watson. He further added, "Until his death, Francis was the person with whom I could most easily talk about ideas. He will be sorely missed." "Francis Crick made an enormous contribution to science and his discoveries helped to usher in a golden age of molecular biology," said Lord May, president of Britain's Royal Society. "Francis Crick made not one but many great Scientific discoveries," said Matt Ridley, author of *Genome* and *Nature Vs Nurture*. Steve Jones, professor of genetics at University College London added: "Francis Crick was the Charles Darwin of the 20th century." Graham Allen, Academic Secretary of the University of Cambridge, paid this tribute to Crick: "We are deeply saddened to hear of the death of Francis Crick today. The impact of his work on how we understand ourselves, and the world we live in is inestimable. We are grateful that Cambridge provided the intellectual setting that allowed Crick and Watson to make their pioneering contribution to the development of modern Biological Sciences."

Francis Crick's entrance into the Eagle pub in Cambridge on February 28, 1953 has gone down as one of the most famous moments in history. "We've discovered the secret of life," is a reputed sentence believed to have been told by Francis Crick to his stunned colleagues. On hearing this announcement only a few people at the time even thought that it was interesting enough to merit their attention. Decades later however, the discovery's impact could be seen everywhere. It laid the foundation for the biotechnology industry, enabling scientists to engineer genetically modified food products like bigger tomatoes, pest resistance cotton, doctors could pursue gene therapy to treat diseases, and police could solve crimes through DNA evidence, scientists were able to unveil the entire human and other species genomes. It was therefore in fitness of things that the 50th year of the discovery of DNA was celebrated at the famous Eagle pub in Cambridge, which was witness to the first historic informal announcement of the discovery of DNA. Biotechnology is now a $30 billion-a-year industry that has produced some 160 drugs and vaccines, treating everything from breast cancer to diabetes. Seven million farmers in 18 countries have grown genetically engineered crops last year, allowing them to grow food with fewer pesticides. Twenty first century will most likely witness unheralded discoveries and inventions in the field of biomedical research, the beginning of which has been heralded with the successful completion of the Human Genome Project. All of these scientific and technological marvel discoveries and inventions owe their genesis to the discovery of the structure of DNA. Francis Crick's name has been enshrined with the name of DNA and will therefore remain eternal in the annals of human history.

Francis Harry Compton Crick was born in Northampton, England, on June 8 1916, to a shoe factory owner Harry Crick and his wife Annie Elizabeth Wilkins. His father and uncle ran a family firm, which produced boots and shoes. Neither of his parents was scientifically inclined but Francis manifested an early interest in science. Fiercely inquisitive from a young age, he read avidly. By the time he was 10, he was conducting chemical experiments at home, blowing up empty bottles with explosive mixtures, a practice soon banned by his parents. He studied at Northampton Grammar School. From Northampton Grammar School he won a scholarship to join the Mill Hill School, London. He was not exceptionally talented. When he was about 12 years of age, he lost his religious faith, an event, which he later saw as the determining factor in his choice of fields for scientific research. He said "I realised early on that it is detailed scientific knowledge which makes certain religious beliefs untenable," and his scientific endeavours thereafter usually touched on problems, which had seemed beyond the power of science to explain.

Crick read physics at University College, London, where he obtained a second class honours degree in Physics in 1937. He started his research for a Ph.D. under Prof Andrade, but this was interrupted by the outbreak of war in 1939. During the war period he worked as a scientist for the British Admiralty, Teddington, mainly in the fields of magnetic and acoustic mines. He was given a job in scientific intelligence at the Admiralty, but was soon itching to find some more interesting field of inquiry. He knew he did not want to design weapons for the rest of his life. The problem was that he was unsure what he wanted to do. In the end he decided to enter the life sciences. He was encouraged by the thought that "since I essentially knew nothing, I had an almost completely free choice". One day he was chatting with some naval officers about recent advances in antibiotics and realised he knew almost nothing about the subject. Then and there he invented a "gossip test", which holds that whatever you are interested in, you gossip about. Applying the test to himself, he discovered that there were two subjects that interested him most: the border between the living and non-living and the workings of the brain. Although molecular biologists were regarded at the time as little more than cranks by many in the scientific community, Crick chose molecular biology as the more promising field.



*Watson (left) and Crick with their DNA model (© Antony Barrington Brown, 1953)*

In 1947, he left the Admiralty and began studying biology. Armed with this modest biology experience he joined Max Perutz at the Cavendish Lab, in Cambridge. Sir Lawrence Bragg was directing a new unit of the lab where they were using X-Ray crystallography to study protein structure. Max Perutz was working on the structure of heamoglobin and Cricks thesis project was on X-Ray Diffraction of Proteins. Crick continued with his studies, joining the Cavendish Laboratory's Medical Research Council unit in 1949 and completing a PhD in 'X-ray diffraction: polypeptides and proteins' in 1954, a year after his famous discovery.

It was in 1951 that he first met the man with whom his name would forever be linked. Chicago-born James Watson, who had just arrived at the Cavendish, was particularly interested in the structure of nucleic acids and proteins; Crick believed that DNA was the means by which genetic information passed from one generation to the next. Although Crick was 12 years older, he and Watson became close immediately. The two men quickly realised that they shared a common interest in unlocking the structure of DNA. The historic moment came at their second attempt to build an accurate model of DNA - their work, in association with Maurice Wilkins and Rosalind Franklin from King's College, London, showed its structure was that of a 'double helix', like a twisted ladder. The classic paper on the discovery of the structure of the DNA was published in Nature in April, 1953. The order of appearance of their names in this historic article was decided by the toss of a coin. When asked to comment on the discovery of DNA, Crick was disarmingly modest about his role in revealing its nature. "We were lucky," he said. "Like America, it was just waiting to be discovered."

After the double helix model, there were still questions about how DNA directed synthesis of Proteins. Crick and some of his fellow scientists including Watson were members of the informal "RNA Tie club", whose purpose was "to solve" the riddle of the RNA structure and to understand the way it builds proteins. The club focussed on the "central Dogma" where DNA was the storehouse of genetic information and RNA was the bridge that transferred this information from the nucleus of the cytoplasm, where the proteins were made. The theory of RNA coding was debated and discussed, and in 1961, Crick and Sydney Brenner provided genetic proof that a triplet code was used in genetic material. For most of his career, Crick was at Cambridge working for the Medical Research Council (MRC).

In 1976 he left Cambridge and moved to the Salk Institute, California. Collaborating with Caltech cognitive scientist Christof Koch, he set out to find what he called "the neural correlates of consciousness," arguing that brain chemistry—as opposed to anything mystical—was responsible for human thought, memory, identity, and free will. Crick has received many awards and honours. He was made an F.R.S. in 1959. He was awarded the Prix Charles Leopold Meyer of the French Academy of Sciences in 1961; he also received the Award of Merit of the Gairdner Foundation in 1962. Together with Watson he was a Warren Triennial Prize Lecturer in 1959 and received a Research Corporation Award in 1962. He shared the Lasker Foundation Award, in 1960, with Watson and Wilkins. In 1962 he was elected a Foreign Honorary Member of the American Academy of Arts and Sciences, and a Fellow of University College, London. He was a Fellow of Churchill College, Cambridge, in 1960-1961, and remained a non-resident Fellow of the Salk Institute for Biological Studies, San Diego, California, until his death. He was appointed to the Order of Merit in 1991. In 1988, he wrote about his experiences in his famous autobiography "What mad pursuit" a personal view of scientific discovery. The scientific fraternities will sorely miss Crick. His name will however, remain eternal in the annals of human history.

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# Recent Devlopments in Science & Technology

## Sculptures to deflect quakes

Scientists have discovered structures called "sonic crystals" that can block traffic noise. They may be able to transform an unpleasant sound into a pleasant one and may even have applications in protecting cities from earthquakes, New Scientist magazine has reported that Francisco Meseguer of the Institute of Material Science in Madrid discovered that a minimalist sculpture in downtown Madrid forms a sound crystal that can block out sound waves in the same way as tiny photonic crystals, arrays of light altering material, can be used to manipulate waves of light.

Sonic crystals are mostly empty space and can be made of anything from glass spheres to metal roads and are set in groups so that sound waves can be bounced off the crystals and against each other. Meseguer and acoustics expert, Jaime Llinares, from the University of Valencia, realised that by scaling up the tiny spheres of photonic crystals to centimeter-sized shapes to match the size of sound waves, they could bounce the sound waves to that they would interfere and cancel each other out. They tested their theory on a sculpture by Spanish minimalist Eusebio Sempere with an array of metal bars at close to the right size, shape and spacing and found that the sculpture did block sound. Their findings have given rise to several applications, including using sonic crystals as aesthetically pleasing ways of blocking out road noise and manipulating and filtering sound. There is even the possibility of transforming traffic noise into, the sound of the trees or of the ocean. Industrial and military applications are also being investigated so that ships and submarines could not be detected by sonar.

*Source : New scientist*

## Organic Farming Generates Longer-Lived Plants

According to report published in *Proceedings of the National Academy of Sciences* plant life-span can be increased by growing them with the method of organic farming. This is the merits of conventional versus organic farming.

To test how plants fare under different growing conditions, Autar K. Mattoo of the U.S. Department of Agriculture and his colleagues set up two patches of tomato plants at a Maryland farm site. The team covered one section with a typical chemical treatment known as black polyethylene (BP), whereas the other received natural fertilization from the hairy vetch legume (HV), which acts as an organic mulch. The researchers analyzed differences in growth patterns, gene expression and overall plant health between the two groups over three different growing seasons. After 65 days in the fields, the researchers noticed clear signs of improved health from the HV-fertilized tomatoes compared with the BP-treated plants. In addition, the plants growing in organic mulch lived longer and could more successfully fend off disease. When they analyzed the plants, the scientists found that five types of genes were more highly expressed in the organically grown tomatoes compared with the traditionally cultivated ones. The team posits that the increased expression stems from the more regulated supply of nutrients, including carbon and nitrogen, that the legume cover provides.

*Source : Scientific American*

Complied by : Kapil Tripathi

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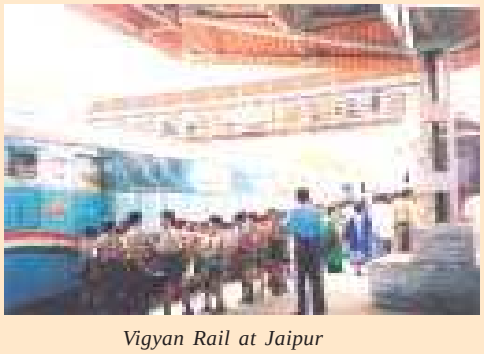
*VP News (Vigyan Rail...) contd. from page....36*

The Vigyan Rail next moved to Kota on July 13, 2004. Shri Tanmay Kumar, District Magistrate, Kota inaugurated the exhibition. Shri S. K. Sharma, DRM was present during the inauguration. About 50000 people visited the exhibition during the two-day halt of Vigyan Rail in Kota.

The next halt of Vigyan Rail was at Ajmer, where it was stationed during 15-17 July 2004. The Vigyan Rail was inaugurated by Shri Ashwini Bhagat, Collector, Ajmer. Students were very enthusiast about the exhibition and always there was long queue in the station to see the exhibition. Almost all the schools at Ajmer arranged conducted trips for their students to visit Vigyan Rail. Schools from far-flung areas arranged buses for their students. About 40,000 people visited Vigyan Rail at Ajmer.



*Vigyan Rail at Jaipur*

Vigyan Rail reached Jodhpur on July 18, 2004 and was stationed up to 22 July 2004. Shri Santokh Singh, DRM, Jodhpur Division inaugurated Vigyan Rail. Shri Atul Sharma, Commissioner, Jodhpur visited Vigyan Rail on July 20, 2004. He took keen interest in the exhibition and appreciated the efforts made by Vigyan Prasar. Since there were huge crowds to see the exhibition, timings were extended the exhibition started one hour early (0900 hrs) and was kept open up to 1900 hrs. AIR, Jodhpur gave news about Vigyan Rail everyday in their morning program, which included interviews of eminent persons who visited Vigyan Rail. Large number of school children from Jodhpur as well as from far-flung areas visited the Vigyan Rail.

Vigyan Rail next moved to Bikaner on July 23, 2004 and was stationed upto July 26, 2004. Shri Alok, Collector , Bikaner inaugurated the Vigyan Rail in the presence of Shri V. K. Jain, DRM, Sh Ratan Lal, ADRM and other dignitaries. About 700 school children were present at the time of inauguration. Most interesting part of the inaugural function was traditional dance performed by school children. About 120 local schools and 100 schools from outside Bikaner organized trips to the exhibition. About 70000 people visited the exhibition at Bikaner.

After completing its journey in Rajasthan, Vigyan Rail entered Punjab and reached Ferozepur, where it was stationed during 27-30 July, 2004. Shri Dharam Singh, DRM, Ferozepur Division inaugurated the exhibition. Over 80 schools from Bhatinda, Fazilka, Abohar, Makhu, Guruharsahi and other places visited the Vigyan Rail. About 30,000 visited the exhibition at Ferozepur.