Registered with the Registrar of Newspapers of India: R.N. 70269/98

ISSN : 0972-169X
Postal Registration No. : DL-11360/2005

Monthly Newsletter of Vigyan Prasar

DREAM 2047

February 2005 Vol. 6 No. 5 Price: Rs. 5.00

VP News

Padma Bhushan for Professor V. S. Ramamurthy

Professor Valangiman Subramanian Ramamurthy, Chairman of Governing Body, Vigyan Prasar, and Secretary, Department of Science and Technology, has been conferred Padma Bhushan by Government of India for the year 2005 for his service to the nation. An eminent nuclear physicist, Professor Ramamurthy has made important contributions, both experimental and theoretical, in the areas of nuclear fission, statistical and thermodynamic properties of nuclei and medium energy heavy ion reaction mechanism. He has co-authored a monograph on *Nuclear Radiation Detectors*. Professor Ramamurthy is the Chairman, Standing Advisory Group on Nuclear Applications, IAEA, Vienna. He started his career in 1963 at the then Atomic Energy Establishment (the present Bhabha Atomic Research Centre). In 1969 he moved to Institute of Physics, Bhubaneswar, as Director. In July 1995, Professor Ramamurthy assumed charge as Secretary to the Government of India, Department of Science and Technology, New Delhi. Under his leadership, the Department of Science and Technology has taken several new initiatives towards the promotion of Science and Technology in the country. Professor Ramamurthy has also been taking keen interest in carrying the results of research in the laboratories to the people residing in the rural areas to improve their quality of life. DST being the nodal Department for coordinating bilateral and mutual international programmes of the Government of India in the area of Science and Technology, Professor Ramamurthy has been deeply involved in several joint S&T programmes involving other countries and international organizations. Professor Ramamurthy is a fellow of a number of Science and Engineering academies. He was conferred the Best Scientist Award at the 90th Session of the Indian Science Congress held at Ahmedabad during 02-07 January 2005. Professor Ramamurthy has been guiding the programmes of Vigyan Prasar with keen interest. He played a major role in translating the idea of Vigyan Rail – Science Exhibition on Wheels into reality. Vigyan Prasar heartily congratulates him for the honour bestowed on him.

Inside

VIPNET Activities in Uttar Pradesh

Vigyan Prasar (VP) organized a two-day VIPNET workshop for Science Club coordinators and members at Etah (Uttar Pradesh) on December 30-31, 2004. The workshop organized at R.L.C. Inter College, Sarvodaya Ashram, Etah was attended by over a hundred participants from the 10 districts of Uttar Pradesh. The Local host was Kishore Gramodyog Seva Sansthan, an NGO from Etah.

The Workshop was inaugurated by Shri R. P. Shukla, District Magistrate, Etah, with the traditional lighting of the lamp. The function was presided by Shri Ram Lal Kushwaha, Ex. Chairman, Madhyamik Shikshak Sangh, Etah. Mr. Shivendra Dev Misra, Principal R.L.C. Inter Colleg, Etah, was the guest of honor on this occasion. In his inaugural speech, Shri R. P. Shukla emphasized

contd. on page....24

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

Published and Printed by Dr. Subodh Mahanti on behalf of Vigyan Prasar, C-24, Qutab Institutional Area, New Delhi - 110 016 & Printed at S. Narayan & Sons, B-88, Okhla Indl. Area, Phase - II, New Delhi - 110 020
Editor : Dr. V.B. Kamble

Taking the Bull by the Horns

It is not even two months since we witnessed one of the most disastrous events of recent times – the Great Asian Tsunami of 26 December 2004. It took several days to assess the impact of this unprecedented natural disaster that took toll of over 15,000 people in India and completely ravaged the eco-systems of coastal zones. In economic terms, the damage was estimated at 5,500 crore Rupees. Tsunamis do not make headlines any more in the media. It is a thing of the past. The only reminder of the disaster is the names of the contributors to the tsunami relief fund, appearing in newspapers and on television. Perhaps, we derive great satisfaction through our one time contribution - cash or kind - to the affected people. No longer do we find it then necessary even to think of tsunamis. In any case, how long can one afford to think or talk about a single event? How many of us still think about the devastating earthquake that rattled Gujarat only four years ago? No doubt, we must look ahead in life, but can we afford to be complacent?

The giant killer waves were only one of the many disasters against which we need to protect ourselves. Surely, disasters do not follow any calendar. If not tsunamis, it could be an earthquake, cyclone, flood, land-slide, or drought in some other part of the country – anytime. It could affect you, me, or anyone else. It was the super-cyclone in Orissa in 1999, earthquake in Bhuj in 2001 and tsunamis in 2004. We were totally unprepared this time – as in the past! Within a short span of six years, we have already experienced three major natural disasters. It is high time we geared up to face the next one. But, where will the next natural disaster strike and when? And how shall we face it? That is a million dollar question!

Surely, we cannot afford to remain indifferent in the years to come and be mute spectators to the loss of life and enormous damage to property. The level of public understanding about the occurrence of the disaster, disaster preparedness, and a quick response play an important role in minimizing the loss of life and damage to property. The lack of both awareness and preparedness about the technology to build earthquake resistant houses was dramatically demonstrated during the Bhuj earthquake. It is the houses – which were not resistant to the earthquake – that killed thousands in Gujarat, not earthquake. It was the lack of education that killed thousands, not tsunamis. The death toll steeply shoots up as a result of the low level of understanding of the causes of a disaster, lack of preparedness, and relatively high response time. This is especially true of the developing countries. In developed countries, on the other hand, earthquakes or tsunamis result in much less loss of life or damage to property. The Great Asian Tsunami proved it yet again.

Let us narrate a story how awareness and quick response help face up to a disaster and save large number of lives. The first story relates to a British girl of ten years vacationing at the Phuket island of Thailand on 26 December, 2004. When the sea suddenly receded, she remembered her geography lesson about the impending tsunamis. She immediately alerted the tourists in the region and was instrumental in getting the area evacuated. Application of the knowledge she acquired at the school and her quick response helped save lives of over 100 tourists.

Closer home, yet another story that appeared in some sections of the press relates to the tsunami ravaged Tamil Nadu, and is a reminder of the vital role that modern communications technology can play in mitigating the impact of natural disasters. The son of one of the fishermen in Nallavadu, a coastal town, was in Singapore, watching a news item about the earthquake that had just occurred off the coast of Indonesia. Worried about the potential impact on his family of giant waves that were reported to be spreading across the Indian Ocean, he telephoned his sister in Nallavadu. He told her to leave immediately, and to urge others to do so. Using the public alert system set up for weather forecasts set up by a non-Government organisation, the 500 families in the village were informed that they had to leave immediately. The result of the warning was that although 150 houses and 200 boats were destroyed, not one of more than 3,500 villagers lost their lives. This story drives home the point that, it is possible to promptly disseminate information to the people in the areas where a disaster is imminent, even with existing detection and communication technology once a warning is received. Alas, only if we had been able to ensure that news of the impending tsunami was spread rapidly to those living in coastal regions around the Indian Ocean.

Living with nature indeed is synonymous with living with natural disasters. It is, therefore, important to realize that natural disasters arise from extreme natural processes that have been taking place on the surface of the Earth for millions of years and follow well known scientific principles. Understanding of these processes and principles by the members of the community could help provide warning signals about the impending disaster and better preparedness. We need a national disaster awareness programme – in a campaign mode – for public understanding of the various disasters and the related scientific aspects using various media, means and modes. We shall then be prepared to take the bull by the horns. The year 2005 is being celebrated as the year of Physics. Let us also observe it as a year of disaster awareness.

❒ **V. B. Kamble**

Editor : **V.B. Kamble**

Address for correspondence : Vigyan Prasar, C-24, Qutab Institutional Area, New Delhi-110 016; Tel : 26967532; Fax : 26965986
e-mail : vigyan@hub.nic.in
website : http://www.vigyanprasar.com

Max Karl Ernst Ludwig Planck

The Originator of Quantum Theory

❑ Subodh Mahanti
e-mail : mahantisubodh@yahoo.com

"Fortunately science, like that nature to which it belongs, is neither limited by time nor by space. It belongs to the world, and is of no country and no age. The more we know, the more we feel our ignorance: the more we feel how much remains unknown…."

Humphry Davy

"Scarcely any other discovery in the history of science has produced such extraordinary results within the short span of our generation as those which have directly arisen from Max Planck's discovery of the elementary quantum of action. This discovery has been prolific, to a constantly increasing degree of progression, in furnishing means for the interpretation and harmonizing of results obtained from the study of atomic phenomena, which is a study that has made marvelous progress within the past thirty years."

Niels Bohr

"Planck's love of fundamental and general problems drove him to take up the blackbody problem, which was independent of atomic models or particular hypotheses. He loved the absolute, and such was the blackbody."

Emilio Gino Segre

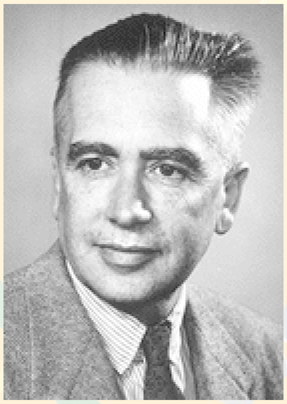
Max Karl Ernst Ludwig Planck is ranked with Albert Einstein as one of the two founders of 20th-century physics. Planck's discovery of a world of discrete, discontinuous "quanta" of energy ushered in the era of modern physics. His discovery was in direct contrast with the apparent continuity of classical Newtonian mechanics. In 1900 Planck postulated the universal constant in nature that came to be known as Planck's constant. It was Planck's discovery, which directly led to the formulation of quantum mechanics 20 years later. As an editor of the *Annalen der Physik,* Germany's leading physics journal, he played an important role in the development of physics as a whole. As an editor, he also welcomed and promoted Einstein's theory of relativity. In fact Planck was the first prominent physicist to endorse Einstein's special theory of relativity. Planck supported the right of women to study science at the university. Planck loved music. He played piano and organ extremely well. It is said that at one time Planck considered music as career. He also loved walking and climbing in the mountains. Planck was a man of deep philosophical and religious conviction. He is one of the very few scientists to be immortalized on a coin (the German DM 2 piece of 1958).

Max Karl Ernst Ludwig Planck

Planck was born on April 23, 1858 in Kiel, Schleswig-Holstein, Germany. His father, Julius Wilhelm Planck was Professor of Constitutional Law in the University of Kiel, and later in Gottingen. Planck's family was truly an academic family. His grandfather and great-grandfather had been professors of theology at Gottingen. Plank's mother Emma Planck (nee Patzig) was his father's second wife. Planck was his father's sixth child (two of the children were from his first marriage to Mathilde Vogt). He was brought up in a tradition, which highly cherished scholarship, honesty, fairness and generosity.

Plank had his early schooling in Kiel before his family moved to Munich in 1867. At Munich Planck joined the prestigious Maximilian Gymnasium in May 1867. At school he performed well but at the same time he did not show any sign of outstanding talent. His school report of the year 1872 while commenting his performance noted: "Justifiably favoured by both teachers and classmates…and despite having ways, he has a very clear, logical mind. Shows great promise." It is said that at the beginning his best subject at school was perhaps music. Almost every year he won the school prize in catechism and good conduct. Towards the end of his schooling at the Maximilian Gymnasium he was drawn to physics and mathematics by his mathematics teacher Hermann Muller.

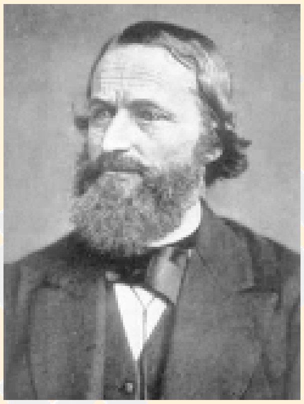
In July 1874 he passed his school leaving examination with distinction. Plank had not decided about his future career. He even explored the possibility of pursuing a musical career. Finally he entered the Munich University on 21 October 1874, where he was taught physics by Philipp von Jolly and Wilhelm Beetz, and Mathematics by Ludwig Seidel and Gustav Bauer. It seems Planck was not much impressed with his teachers at the Munich University. Remembering his student days at the Munich University Planck later wrote: “I did not have the good fortune of a prominent scientist or teacher directing the specific course of my education.” At the beginning Planck took mostly mathematics classes. His physics teacher Philipp von Jolly presented a very bleak picture of the prospect of research career in physics. Jolly described physics as essentially a complete science. A few loose ends remained to be tidied up but on the whole all the major discoveries had already been made. So there was very little prospect of further development. In those days it was not uncommon for a physicist to believe that study of physics was essentially a dead end. It was almost a common belief that everything of importance had already been discovered. But finally Planck decided to study theoretical physics. On describing why he chose physics, Planck later wrote: “The outside world is something independent from man, something absolute, and the quest for the laws which apply to this absolute appeared to me as the most sublime scientific pursuit in life.” He was inspired by the discovery that “pure reasoning can enable man to gain an insight into the mechanism of the world.” In October 1877 Planck moved to the Berlin University, where he was taught by Hermann Ludwig Ferdinand von Helmholtz and Gustav Robert Kirchoff. At Berlin, Planck made independent study of Rudolf Clausius’ writings on thermodynamics. Planck returned to Munich and from where he received his doctorate degree in July 1879. His PhD thesis was on the second law of thermodynamics and it was titled “On the Second Law of Mechanical Theory of Heat.” Planck’s decision to study theoretical physics was a revolutionary step. Theoretical physics was yet to be recognized as a discipline on its own right.



Emilio Gino Segre

After completing his PhD Planck became a Privatdozent at Munich University, a post he held for five years. It was not a salaried post and Plank lived with his Parents. On May 02, 1885, Planck was appointed as an Associate Professor of Theoretical physics at the Kiel University. This appointment, which he held for four years, made Planck financially independent. Planck married Marie Merck on March 31, 1887. Marie was the daughter of a Munich banker. At Kiel Planck worked on thermodynamics. In this he was influenced by his teacher Gustav Kirchoff and by reading Rudolf Julius Emmanuel Clausius’ publications. He published three excellent research papers on applications to physical chemistry and thermoelectricity.

On November 29, 1888, Planck was appointed as an Associate Professor of Theoretical Physics at the University of Berlin. He succeeded his former teacher Kirchoff. Planck was not the first choice. The authorities of the Berlin University was looking for a world-renowned physicist to replace Kirchoff and first they approached Ludwig Boltzman but he did not accept the offer. After Boltzman, the post was offered to Heinrich Hertz but he also refused the offer. Finally the Department of Philosophy of the Berlin University proposed Planck’s name for the post. Planck was strongly recommended by Helmholtz, who was also Planck’s former teacher. While recommending Planck, Helmholtz wrote: “Planck’s papers are very favourably distinguished from those of the majority of his colleagues in that he tries to carry through the strict consequences of thermomechanics constructively, without adding additional hypotheses, and carefully separates the secure from the doubtful…His papers…clearly show him to be a man of original ideas who is making his own paths (and) that he has a comprehensive overview of the various areas of science.” In 1892 Planck was promoted to full professorship. He remained at the Berlin University until his retirement in 1926. In 1914 Planck succeeded in bringing Albert Einstein to Berlin and later Max von Laue, his favourite student and a Nobel Laureate. His lectures on all branches of theoretical physics at the Berlin University were held in high regard within the scientific community for many years. After Planck’s retirement in 1927, Erwin Schrodinger was chosen as his successor.



Gustav Robert Kirchhoff

Planck was fascinated with absolutes in nature, which led him to the laws of thermodynamics and which in turn to the problem of blackbody radiation. It was Gustav Robert Kirchhoff, who in 1859-60 introduced the concept of a blackbody—an object that does not reflect any surface light. A black body is a perfect emitter and absorber of radiation at all frequencies. It should be noted that explaining the radiation given off by a hot body was one of the major challenges in physics at the end of 19^{th}-century. It was known that the intensity of the radiation given off by a hot body increased with wavelength up to a maximum value but then fell off with increasing wavelength and that the radiation was caused by the vibrating atoms in the body. For an idealized emitter like a so-called blackbody it should have been possible to develop a theoretical expression using thermodynamics for its radiation. But there was a problem with the blackbody radiation. Since a blackbody absorbs all frequencies so when heated it should logically radiate all frequencies as well. Based on this assumption, physicists expected the number of radiations in the high-frequency range should vastly outnumber in the low-frequency range. This is because high frequencies have shorter wave lengths and so more number of high frequencies could be packed into the blackbody. But this does not happen in reality. And it could not be explained in terms of physical theories of blackbody radiation developed in 1890s, though a number of radiation laws were indeed developed. In 1896 Wilhelm Wen derived a radiation law that applied only at short wavelengths. Lord Rayleigh and James Jeans developed a law that applied at long wavelengths. Planck decided to find an equation that would be applicable to all wavelengths of the radiation emitted by a hot body. He hit upon the idea of correlating the entropy of the oscillator with its energy.

Postal Stamp an Max Planck

Planck argued that the atoms of a heated black body, an idealized solid, did not radiate energy continuously. They radiated energy in 'discrete amounts'. Based on this idea he deduced a formula, which proved valid for all frequencies or wavelengths of the emitted light. Planck visualized a heated solid as being composed oscillating atoms. These oscillating atoms caused the emission of electromagnetic waves like tiny elementary antennae. And like the receiving antenna of a television set, the oscillating atoms absorbed the radiation falling upon them. But unlike an antenna, which absorbs the incoming waves at all frequencies or in a continuous way, the oscillating atoms emitted or absorbed the energy carried by the electromagnetic radiation in discrete packets or quanta (quanta is plural; the singular form is quantum). In other words the atoms absorbed energy – only at definite frequencies and not at all frequencies. The energy (E) of each quantum had to be related to the frequency (v) of the wave by the formula E = hv, where the Greek letter v is the frequency, and h corresponds to the Planck constant or elementary quantum of action. The value of h, which is a fundamental constant, is 6.63 X 10^{-34} joule-second. Planck's radiation law was expressed as E = nhv, where n = 0, 1, 2, 3, 4, etc. According to this formula the energy of each quantum is proportional to the frequency. This means radiation at low frequencies is easy, as it requires only small packets or quanta of energy. And so a frequency twice as high, radiation would require twice the amount of energy. Thus based on Planck's idea it can be said that the quantum-energy requirements to radiate at high frequency end of the spectrum will be so great that it is very unlikely to happen. Planck thus explained why blackbodies do not radiate all frequencies equally. If temperature is raised it would become easier for the larger quanta of energy to form and accordingly radiation at higher frequencies will become more likely.


The house at Berlin where the plancks had moved in 1905. It was totally destroyed in February 1944 during a bombing raid.

Planck announced his discovery at a meeting of the German Physical Society, held in Berlin on December 14, 1900. His results were later presented in a paper published in the German physics journal *Annalen der Physik* in March 1901. The paper was titled "Zur Theorie der Gesetzes der Energieverteilung im Normal-Spectrum" ("On the Theory of the Law of Energy Distribution in the Continuous Spectrum"). It is from this paper that quantum theory originated.

For his discovery Planck was awarded Nobel Prize in Physics in 1919 for the year 1918. This his how he began his Nobel Lecture, which he delivered on June 01, 1920: "When I look to the time…when the concept…of the physical quantum of action began, for the first time, to unfold from the mass of experimental facts…the whole development seems to me to provide a fresh illustration of the long-since proved saying of Goethe's that man errs as long as he strives. And the whole strenuous intellectual work of an industrious research worker would appear, after all, in vain and hopeless, if he were not occasionally through some striking facts to find that he had, at the end of all his criss-cross journey, at last accomplished at least one step which was conclusively near the truth."

Further he continued: "For many years, my aim was to solve the problem of energy distribution in the normal spectrum of radiating heat. After Gustav Kirchoff has shown that the state of the heat radiation which takes place in a cavity bounded by any emitting and absorbing material at uniform temperature is totally independent of the nature of the material, a universal function was demonstrated which was dependent only on temperature and wavelength, but not in any way on properties of the material. The discovery of this remarkable function promised deeper insight into the connection between energy and temperature which is, in fact, the major problem in thermodynamics and so in all molecular physics…

At that time I held what would be considered today naively charming and agreeable expectations, that the laws of classical electrodynamics would, if approached in a sufficiently general manner avoiding special hypotheses, allow us to understand the most significant part of the processes we would expect, and so to achieve the desired aim…


Heinrich Rudolf Hertz

A number of different approaches showed more and more clearly that an important connecting element or term, essential to completely grasp the basis of the problem, had to be missing…

I was busy…from the day I established a new radiation formula, with the task of finding a real physical interpretation of the formula, and this problem led me automatically to consider the connection between entropy and probability, that is Boltzmann's train of ideas; eventually after some weeks of the hardest work of life, light entered the darkness, and a new inconceivable perspective opened before me..."

Planck himself reluctantly accepted the implications of his discovery. Being a conservative physicist, he did not want to see classical physics destroyed. He later wrote: "I tried immediately to weld the elementary quantum of action somehow in the framework of classical theory. But in the face of all such attempts this constant showed itself to be obdurate…My futile attempts to put the elementary quantum of action into the classical theory continued for a number of years and they cost me a great deal of effort."

There was something unusual about the Plank's formula. While seeking a relationship between the energy emitted or absorbed by a body and the frequency of radiation Planck had introduced a constant of proportionality, which could only take integral multiples of a certain quantity. However, initially Planck himself and his contemporaries did not feel it necessary to pay much serious attention to the quantum discontinuity. In 1900, neither Planck nor other physicists recognized that the new radiation law necessitated a break with classical physics. To them what mattered was the impressive accuracy in explaining the blackbody radiation and it also included the radiation laws developed by Wien and Boltzmann. Thus the Plank's radiation law was quickly accepted by the community of physicists. In 1902 Planck's radiation law appeared in the second volume of Heinrich Kayser's authoritative *Handbook of Spectroscopy*. However, it did not mention of the nature of quantum assumption. In fact at the beginning the quantum concept was subject to a great deal of skepticism. The Dutch physicist Peter Debye later recalled: "We did not know whether the quanta were something fundamentally new or not." Thus Max Jammer commented: "Never in the history of physics was there such an inconspicuous mathematical interpolation with such far-reaching physical and philosophical consequences."


Hermann Ludwig Ferdinand von Helmholtz

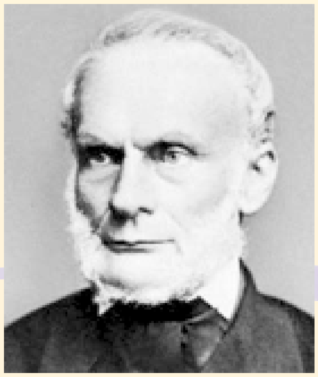
Plank's introduction of quantum was a revolutionary idea. It was a radical break with classical physics. The concept of quanta is fundamental to physics. Commenting upon the implication of Planck's discovery, Einstein wrote: "This discovery (Planck's discovery) became the basis of all twentieth-century research in physics and has almost entirely conditioned its development ever since. Without this discovery it would not have been possible to establish a workable theory of molecules and atoms and the energy processes that govern their transformations. Moreover, it has shattered the whole framework of classical mechanics and electrodynamics and set science a fresh task: that of finding a new conceptual basis for all physics. Despite remarkable partial gains, the problem is still far from a satisfactory solution."

Rapid acceptance of far-reaching implication Planck's idea came with its use in Einstein's prediction of the photoelectric effect. In 1905 Einstein used Planck's discovery in his explanation of the photoelectric effect. Einstein said that light is composed of not only of waves, but also of particles, named photons.

After Einstein, Niels Bohr demonstrated the far-reaching significance of Planck's theory. In 1913, Bohr developed the first quantum theory of atomic structure. Bohr proposed that like Planck's atomic oscillator, the atoms can exist only in certain states. According to Bohr these quantum states correspond to specific energy values and orbits and atoms remaining in these states should not radiate. Finally Planck's quantum concept became the basis of a new theory, named quantum mechanics, which explained all phenomena of the atomic and subatomic world. Quantum mechanics dominated physics of the whole twentieth century.

Planck was a great patriot. He could not think of leaving Germany, his beloved country, even during the two world wars. During the First World War, he prevented the Berlin Academy of Sciences from expelling members belonging to enemy countries. He publicly denied of his signature of the Manifesto of the Ninety-Three Intellectuals, a declaration in support of the German invasion of Belgium. Planck was the only one of the ninety-three intellectuals to deny publicly. After the First World War, he played an important role in rebuilding

German science. He became the President of the Kaiser-Wilhelm Society, which administered some of the best-known scientific and technological research institutes. Planck's reputation was tarnished when he decided to retain his position of influence even after the Nazis came to power. Though Planck did not publicly protest against persecution of the Jewish scientists but he raised the issue with Adolf Hitler himself in 1933. Planck argued that racial laws barring Jews from government positions would endanger the preeminence of German science. Hitler did not accept Planck's suggestion. In 1938, Planck was forced from his positions of influence.



Rudolf Julius Emmanuel Clausius

Planck, while explaining why he was still in Germany said in 1942: "I have been here in Berlin University since 1889…so I am quite an old-timer. But there really are not any genuine old Berliners, people who were born here; in the academic world everybody moves around frequently. People go from one university to the next one, but in that sense I am actually very sedentary. But once I arrived in Berlin, it was not easy to move away; for ultimately, this is the centre of all intellectual activity in the whole of Germany."

Planck endured many personal tragedies in later part of his life. His elder son Karl died from wounds suffered in action in the First World War. His twin daughters Grete and Emma died during childbirth in 1917 and 1919 respectively. During the Second World War, Planck was forced to witness devastation of his country. German science and its institutions were destroyed. Planck's own home was completely destroyed by Allied bombing in 1944 and he suffered great hardship. His youngest son and the last surviving child Erwin was executed for his part in an unsuccessful attempt to assassinate Hitler in 1944. By the end of the war, Planck, his second wife and his son by her, moved to Gottingen.

Planck summarized his work in two books: *Thermodynamik* (*Thermodynamics*, 1897) and *Theorie der Warmestrahlung* (*Theory of Heat Radiation*, 1906).

Planck wrote extensively on the philosophy of science and on religion. He believed in the existence of an almighty, omniscient and beneficent God, identical in character with the power of physical laws. Planck was of the view that science is based on the recognition of a reality external to the observer. He argued that there is only apparent contradiction between causal laws and the freedom of the will. He thought that causality is valid in nature even though it could not be proved.

Planck died on October 4, 1947 in Gottingen. The value "h + 6.62 x 10^{-27} erg.sec" is engraved on his tombstone.

References

1. Kragh, Helge. *Quantum Generations: A History of Physics in the Twentieth Century*. Hyderabad: Universities Press (India) Ltd., 2001.
2. Spangenburg, Ray and Diane K. Moser. *The History of Science: From 1895 to 1945.* Hyderabad: Universities Press (India) Ltd., 1994.
3. *A Dictionary of Scientists.* Oxford: Oxford University Press, 1999.
4. *The Cambridge Dictionary of Scientists (Second Edition).* Cambridge: Cambridge University Press, 2002.
5. Jammer, Max. *Concepts of Mass in Classical and Modern Physics.* Cambridge, Mass.: Harvard University Press, 1961.
6. Segre, Emilio. *From X-rays to Quaks: Modern Physicists and Their Discoveries.* San Fransisco: W. H. Freeman and Co., 1980.
7. Einstein, Albert. *Idea's and Opinions.* New Delhi: Rupa & Co., 1994.
8. Dardo, Mauro. *Nobel Laureates and Twentieth-Century, Physics.* Cambridge: Cambridge University Press, 2004.
9. Planck, Max. *Where Is Science Going?.* Woodbridge, CT: Ox Bow Press, 1981.
10. Planck, Max. *The Genesis and Present State of Development of the Quantum Theory. Nobel Lectures: Physics 1901-1921.* The Nobel Foundation. Amsterdam: Elsevier, 1967.

Form IV-B (see rule 8)

Details of the ownership and other facts relating to monthly newsletter 'DREAM 2047'.

Place of Publication	: New Delhi
Periodicity of Publication	: Monthly
Name of the Publisher&the Printer (on behalf of Vigyan Prasar)	: Dr. Subodh Mahanti
Nationality	: Indian
Address	: Vigyan Prasar C-24, Qutab Institutional Area, New Delhi-110016
Name of the Editor	: Dr. V.B. Kamble
Nationality	: Indian
Address	: Vigyan Prasar C-24, Qutab Institutional Area, New Delhi-110016
Name & Address of the owner	: Vigyan Prasar C-24, Qutab Institutional Area, New Delhi-110016

I, Subodh Mahanti do hereby declare that to the best of my knowledge and belief, facts mentioned above are true.

(Sd) Subodh Mahanti
(Signature of the Publisher)

Cinnamon

The Sweet Spice

❑ T V Venkateswaran
tvv123@rediffmail.com

Tasting sweet and fragrant as well as, warm and aromatic, cinnamon is one of the ancient spices. Cinnamon, usually regarded as the bark of the Cinnamomum zeylanicum tree, (or 'true cinnamon') is native to Srilanka, parts of South India and the Tenasserim Hills of Burma. However another variety Cassia is widely prevalent in China. Like the spice itself the name of the spice too is 'spicy'! In India and Iran, it is called *darchini*, meaning "wood from China", which more accurately describes cassia; much of which came from China where large groves of trees grew around the city of Kweilin (now called Guilin). ["kwei" means cinnamon, and "lin" means forest in Chinese.] In Tamil and south Indian languages it is called as 'lavanga pattai (bark of the lavangan)'; a mistaken notion that the bark is from the clove tree (lavang). The name in English 'Cinnamon' come from the Malay word, "kayumanis", meaning 'sweet wood'. In Italian it is 'canella' meaning "little cannon tubes" that the rolled up quills of bark resemble.

Figure 1: Cinnamon

History

In the Bible (exodus 30), there is a reference to cinnamon as an ingredient in holy anointing oil used in the ritual at the Tabernacle erected by Moses. The Roman Empire imported huge amounts of cinnamon, and it may have been used mostly in perfumes and fragrances and to flavor wines, but it was not favored as a cooking spice. It is reported that the (in) famous Nero burned year's worth of cinnamon on his wife's funeral pyre in 1 CE - that time wroth more than gold- as an extravagant gesture meant to signify the depth of his loss. Cinnamon was once more valuable than gold and has been associated with ancient rituals of sacrifice or pleasure in ancient Europe. In Egypt, it was sought for embalming, perhaps because cinnamic acid (and also myrrh) has antibacterial effects. In ancient China, cinnamon is related to the traditional Chinese religious myths- it is said that the mouth of Yellow river has a garden of paradise full of cassia trees. In Indonesia, a wine prepared from cinnamon is essential for completion of the marriage ceremony while in Mexico, Asiatic countries, Arabia and North Africa it was valued in cooking.

During the Middle Ages and subsequently, cinnamon, was sold in Europe by Arabian traders who obtained it from Ceylon. It became a favorite flavour in many banquet foods and was regarded as an appetite stimulator, a digestive, an aphrodisiac, and a treatment for coughs and sore throats. The cinnamon (or cassia) trade was controlled by Venice in the 13th and 14th centuries, and resulted in the city becoming very wealthy.

The demand for cinnamon was enough to launch a number of explorers' enterprises. The Portuguese invaded Sri Lanka immediately after reaching India in 1536. The Sinhalese King paid the Portuguese tributes of 110,000 kilograms of cinnamon annually. An increasing demand for cinnamon led to the Dutch fighting the Portuguese, and in the mid-17th century Ceylon's cinnamon trade was taken over and controlled by Holland. The Dutch captured Sri Lanka in 1636, cinnamon was the most profitable spice in the Dutch East India Company trade. They established a system of cultivation that exists to this day. In its wild state, trees grow high on stout trunks. Under cultivation, the shoots are continually cropped almost to ground level, resulting in a low bush, dense with thin leafy branches. From these, come the finest quills.

The Dutch forcefully monopolized cinnamon; to keep up prices in 1760, they burnt huge amounts in Amsterdam to create a shortage. In 1795, the English seized control of Ceylon with a view to garner its profit. The British established cinnamon, tea and rubber plantations and thousands of Tamils from southern India were brought to Srilanka to work on these plantations. However, cinnamon saplings were transplanted by the Dutch for cultivation in Indonesia and by the French to plantations in Mauritius, Reunion islands and Guyana.

The Plant

Cinnamon is the common name for the trees and shrubs that belong to the genus Cinnamomum. There are many different species, listed as variedly as from 50 to 250 types. The two main varieties are Cinnamomum cassia and Cinnamomum zeylanicum. C. zeylanicum is also known as 'Ceylon' cinnamon – zeylanicum in Latin means Ceylon. Best cinnamon grows along the coastal strip near Colombo.

Cinnamon is a tropical evergreen tree of the laurel family (Lauraceae) growing up to 7m in its wild state; though in plantation it maybe pruned to look like a bush. Cultivated plantations grow trees as small bushes, no taller than 3 m, as the stems are continually cut back to produce new stems for bark. It has deeply-veined ovate leaves that are dark green on top, lighter green underneath. The bark is smooth and yellowish. Both the bark and leaves are aromatic. It has small yellowish-white flowers with a disagreeable odour that bear dark purple berries. It prefers a hot, wet tropical climate at a low altitude.

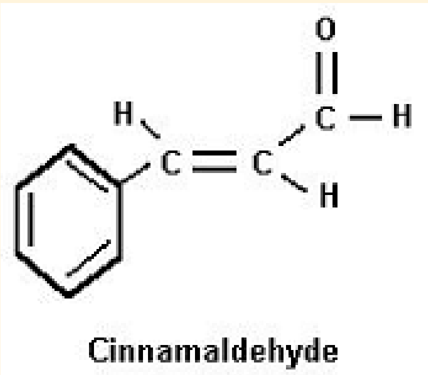


Figure 2

Eight to ten lateral branches grow on each bush and after three years they are harvested.

The Spice

Cinnamon is the inner bark of these trees. Stem bark of the plant is the commercially exploited part, though; cinnamon leaves may serve as a substitute for Indian bay leaves. Branches are cut from trees and bark is peeled off. The Sri Lankan farmer harvests his main crop in the wet season, cutting the shoots close to the ground. In processing, the shoots are first scraped with a semicircular blade, then rubbed with a brass rid to loosen the bark, which is split with a knife and peeled. They are left to dry. After few days the inner bark and the outer get separated and the outer bark, cork and the pithy inner lining are scraped off. Inner barks are left to dry further. As they dry, the inner bark curl inwards producing what is called as a quill. The peels are telescoped one into another forming a quill about 100 cm long and filled with trimming of the same quality bark to maintain the cylindrical shape. After four or five days of drying, the quills are rolled on a board to tighten the filling and then placed in subdued sunlight for further drying. Finally, they are bleached with sulphur dioxide. They are then cut into uniform lengths and graded according to thickness, aroma and appearance.

Spice produced from Zeylancicam are light brown or tan in colour with delicate taste. Cassia that grows in China, Indonesia and several Southeast Asian countries produce darker reddish brown with stronger pungent flavour. Cinnamon from Zeylancicam is considered by the commercial world as far superior and from Cassia as essentially adulterant, though in most homes distinction is not made. Cinnamon comes in 'quills', strips of bark rolled one in another. The pale brown to tan bar strips are generally thin, the spongy outer bark having been scraped off. The best varieties are pale and parchment-like in appearance.

Main Constituents

trans-**Cinnamaldehyde** (**C_9H_8O**) is a major constituent of cinnamon bark, and it provides the distinctive odor and flavor associated with cinnamon. Two phenylpropanoids; cinnamic aldehyd (3-phenyl-acrolein) and eugenol (4-(1-propene-3-yl)-2-methoxy-phenol dominates the essential oil of the cinnamon bark. Other phenylpropanoids (safrole, coumarine, cinnamic acid esters), mono- and sesquiterpenes, although occurring are only in traces; yet they do significantly influence the taste of cinnamon. Another trace component relevant for the quality is 2-heptanone (methyl-n-amyl-ketone). The slime content of the bark is rather low at 3%.

Culinary Uses

Since Ceylon cinnamon is native in South Asia, it is not surprising that the cuisines of Sri Lanka and India make heavy use of it. It is equally suited for the fiery beef curries of Sri Lanka and the subtle, fragrant rice dishes (biriyanis) of the Imperial North Indian cuisine. It is also widely in use for flavouring tea. Cinnamon is also popular in all regions where Persian or Arab influence is felt: West, South West and Central Asia, Northern and Eastern Africa. Although cinnamon was very popular in Europe in the 16th to 18th centuries, it's importance is now rather shrunken: the main application for cinnamon in Western cooking are several kinds of desserts; stewed fruits, for instance, are usually flavoured with a mixture of cloves and cinnamon. Currently, cinnamon is regarded as a wonderful aroma in baked goods, but its taste is of limited appeal in the western world.

In India, cinnamon is applied as a whole; the bark pieces are fried in hot oil until they unroll. As they unroll in hot oil they release the fragrance; not to over burn and spoil, temperature is quenched by adding other components, like tomatoes, onions or curd. In most other countries, powdered cinnamon is preferred. The powder should be added shortly before serving, as it turns slightly bitter if cooked for long. Powdered cinnamon is contained in several spice mixtures, like North Indian garam masala, curry powder and Arabic baharat, further it is an optional ingredient for the classical French mixture quatre épices. In Kutch region it is reported that "cinnamon buds" that is the unripe fruits harvested shortly after the blossom are also used as a spice.

Medicinal Uses

Cinnamon is one of the oldest herbal medicines known, having been mentioned in Chinese texts as long as 4,000 years ago. In traditional herbal remedies Cinnamon is said to have properties of astringent, warming stimulant,

(contd. on page 22)

The Paintal Era

❑ B.S. Padmanabhan
e-mail: groenter@rediffmail.com

If there are now effective techniques for treatment of heart and lung ailments like breathlessness, cough and blood pressure, it is in no small measure due to the research work of Dr. Autar Singh Paintal, a renowned physiologist and former Director General of Indian Council of Medical Research, who passed away on December 22, 2004 at the age of 79.

Spanning more than four decades, his studies in the field of visceral physiology had resulted in discoveries acclaimed the world over as shedding new light on the behaviour of several visceral receptors in health and diseases. In fact, the significance of his findings was such that the Nobel Laureate Prof C. Heymans has, in one of his monographs, referred to the state of knowledge before these findings as "pre-Paintal era".

Dr Paintal will be remembered not only for his contributions to medical research but also for his deep commitment to promotion of ethics and values in scientific research in general and medical research in particular. He has been a strong votary of accountability in scientific research.

Born in Mogok in Burma where his father was in the medical service, Autar Singh came to India as a lad of 14. He had his high school and intermediate education in Lahore and medical education in Lucknow Medical College. After getting MBBS degree he went to Edinburgh as a Rockefeller Fellow and obtained Doctorate in Physiology.

Autar Singh paintal

It was at Edinburg that he was introduced to the subject of visceral sensory mechanism by his teacher Prof D Whitterbridge and that was the starting point of the series of discoveries he had to his credit. His work at Edinburg on electrical responses of the skin in normal and psychotic persons led to his working out a new index for evaluating galvanic skin response. This was named "Paintal Index", which reportedly formed the basis of the lie detector test now universally deployed in crime detection. He also developed new techniques for dissecting and recording impulses from single active nerve fibres and providing their conduction velocities.

Back home he worked for a year at the Defence Laboratory in Kanpur, where his main assignment was testing of clothes and drugs for the Army. But he utilized his spare time to pursue his chosen field of specialization. The result was his discovery of "gastric stretch receptors", which control the amount of food and water intake of a person. This opened up the field for study of electrophysiology of the gastro-intestinal tract. His conclusion that these receptors constituted the peripheral mechanism for the immediate satiation of hunger and thirst formed the nucleus for further work in this field.

In 1954 he joined the Vallabhbhai Patel Chest Institute under the Delhi University as Assistant Director. His research work here led to the discovery of ventricular pressure receptors and juxtrapulmonary capillary or J receptors. He found that the J receptors are stimulated by a rise in the intestinal fluid volume in the lungs and a rise in pulmonary blood flow. He also found that when stimulated these receptors produced rapid shallow breathing. This was regarded the foremost among his discoveries and he was best known for this work. The knowledge gained in this field through his work is being applied in clinics all over the world to deal with dyspnoea and cough, besides providing relief to millions of sufferers of breathlessness.

Two years later he went to New York as Visiting Professor at Albert Einstein College of Medicine and then worked at the Universities of Utah and Goettingen. Back home in 1958 he joined the All India Institute of Medical Sciences as Professor of Physiology and continued his research work there for six years. During this period he came out with the discovery of pressure-pain receptors of muscles.

In 1964 he returned to Vallabhbhai Patel Chest Institute but this time as Director, which position he held for two decades. It was the most productive period in his research career in the sense that he came out with a number of findings, which shed further light on visceral sensory mechanism. He showed that the J receptors produced sensations of throat and dry cough.

In 1986 he was chosen to head the Indian Council of Medical Research (ICMR) as Director General. He was not new to ICMR, as he had been a member of various Scientific Committees of ICMR. He was also a member of the ICMR Review Committee headed by Dr. B. Ramamurthi. As such he was quite conversant with the strengths and weaknesses of ICMR and he therefore set as his immediate task the toning up of the research work in ICMR institutions to produce effective technologies for prevention and cure of major diseases. He was keen that ICMR should restructured on the lines of the CSIR as recommended by the Ramamurthi Committee but this is yet to materialize.

(contd. on page 20)

The Elusive Higgs Boson

❑ P.K. Mukherjee

What is the mechanism behind the generation of mass? That is one of the most- asked, most- hotly persuaded question in physics today. Many of the experiments the worlds over being performed on particle accelerators are looking into the mechanism that gives rise to mass.

But what, after all, this mechanism is? According to physicists, an interaction takes place between a particle called Higgs particle, a boson, with other particles. It is this interaction that endows these particles with mass. However, the idea of one particle giving another mass seems to be a bit counter- intuitive. After all, isn't mass an inherent characteristic of matter? If yes, how can one entity impart mass on all the others by simply interacting with them? An oft-quoted analogy describes it well. Imagine you are at a Bollywood party. The crowd is rather thick, and evenly distributed around the room, chatting. When a big film star arrives, the people nearest the door gather around him. As he moves through the party, he attracts the people closest to him; and those he moves away from, return to their original conversations. Thus by gathering a fawning cluster of people around him, the film star has gained momentum, an indication of mass. This clustering effect is the so—called Higgs mechanism.

Peter Higgs

In this mechanism, the particle imparting mass to all others is called Higgs boson. The British physicist Peter Higgs first proposed the existence of Higgs boson in the 1960s. Through his two research papers published in 1964 and 1966, respectively, in the journals Physics Letters and Physical Review, Higgs drew the attention of physicists the world over to this new particle.

According to Peter Higgs, Higgs boson cerates a sort of lattice, referred to as the Higgs field, that fills the entire universe. The particles acquire mass through their interaction with this all – pervading field. The mass acquired by a particle depends on the strength of its coupling with the Higgs field. In other words, greater the strength of coupling of the particle with the Higgs field greater is the particle's mass. This interaction of a particle with the Higgs field is referred to as the Higgs mechanism.

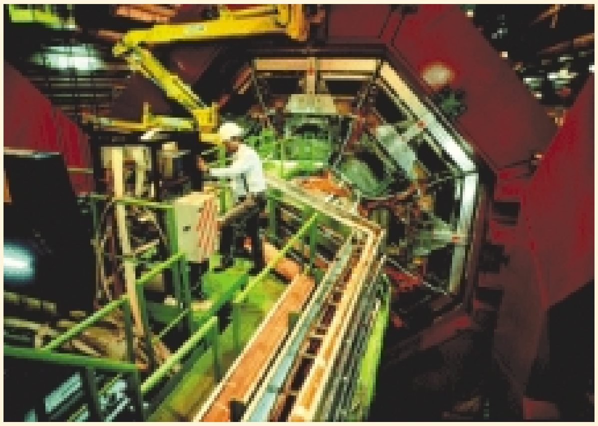
The importance of Higgs boson is so central to current thinking in particle physics that it is often referred to as the 'God Particle'. However, Peter is not particularly happy with this nomenclature. He is said to have quoted; 'I am not a believer in God, and this might be offensive to believers. It is not an expression used by anyone in particle physics."

The hypothesized Higgs field seems to be something like an electromagnetic field, in that it affects the particles that move through it, but it is also related to the physics of solid materials. It is known that when an electron passes through a positively charged crystal lattice of atoms (a solid), the electron's mass can increase as much as forty times. The same might be true in the Higgs field; a particle moving through it creates a little bit of distortion— like the crowd around the film star at the Bollywood party- and that lends mass to the particle. In fact, the question of mass has been an especially intriguing one and has left the Higgs boson as the single missing piece of the Standard Model yet to be spotted. It is well known that the Standard Model is a significantly important theory of particle physics, which has been developed by a large number of physicists after their painstaking work for over several decades. It describes three of the Nature's four basic forces (Particle Physicists often prefer to use the word 'interaction' instead of the word 'force'), namely, the electromagnetic and the strong and weak nuclear forces. Electromagnetism has been fairly well understood for many decades. Recently, physicists have learned much more about the strong or color force which binds the constituents of the atomic nuclei together; and the weak force which governs radioactivity and hydrogen fusion (which generates the sun's energy).

The electromagnetic interaction is transmitted by mass-less photons which are tiny packets of electromagnetic radiation. The strong interaction between quarks is mediated by mass-less gluons; while the weak interaction between leptons and quarks is transmitted by massive particles $W^{\pm}$ and Z^0. Unlike photons and gluons they have very large masses (about 100 proton masses). That is the reason why they are also called massive vector bosons. Incidentally, photons; $W^{\pm}$ and Z^0 vector bosons are all spin-1 particles (a particle with spin- 1 was earlier designated as a vector particle; this name is now redundant although it is still in vogue).

It is interesting to note that in the underlying theory of the Standard Model, there are three W bosons; W^+ and W^- and a neutral W^0 boson, plus another neutral boson called B^0. However, we observe physically two neutral bosons, the photon and Z^0 boson. According to particle physicists, these neutral bosons may be regarded as the quantum mechanical 'mixture' of the W^0 and B^0 states (The parameter that describes this mixing is called the weak mixing angle, and it is an important parameter of the model).

There is an interesting and important difference between the electromagnetic and strong interactions on the one hand and the weak interaction on the other. The messenger



Large Electron Positron (LEP) collider at CERN Geneva (Switzerland)

or carrier particles for both the electromagnetic (photons) and strong interactions (gluons) are mass-less particles while those for the weak interaction ($W^{\pm}$, Z^0 vector bosons) are , massive particles. In fact, they are some of the most massive particles known. The first inclination is to assume that $W^{\pm}$ and Z^0 particles simply exist and interact with other elementary particles. But, for mathematical reasons, the giant masses of $W^{\pm}$ and Z^0 raise inconsistencies in the Standard Model. In fact, it is to take care to these inconsistencies that Peter Higgs had to hypothesize the existence of Higgs boson.

The simplest theories predict the existence of only one Higgs boson. However, others opine that there might be several. In fact, the search for the Higgs boson (s) is one of the most exciting researches happening, because it could lead to completely new discoveries in particle physics. Some theorists say that is could bring to light entirely new types of strong interactions while others believe that the research might reveal a new fundamental physical symmetry called "super symmetriy", brining in a new set of particles called super symmetric particles. The possible existence of such particles may in future lead to the realization of an age-old dream of physicists to unify all the four basic forces of nature.

The discovery of Higgs boson will probably also reveal new and exciting facts in physics, addressing the 21^{st} century agenda of compelling question about dark matter and dark energy, the existence of extra dimensions and the fundamental nature of matter, energy, space and time. No wonder that the physicists are desperately looking forward to detecting the Higgs boson because it would plug a hole in theory that is both their greatest triumph and their greatest headache.

The direct search for Higgs boson was being carried out at the Large Electron Positron (LEP) Collider at CERN (European Centre for Nuclear Research) in Geneva. In the LEP accelerator, electrons and positrons traveling in opposite directions, around a ring which is 27 km in circumference, at velocities close to the speed of light, were made to collide against each other. In the process, the colliding particles created bursts of high energy, which almost instantaneously rematerialized streams of subatomic particles. Higgs boson could possibly also be present in the subatomic debris. But, being highly unstable it would only last for a small fraction of a second, and then decay into other particles. So, in order to tell whether the Higgs boson appeared in the collisions, researchers had to look for evidence of what it would have decayed into.

The search for Higgs boson was being made at the LEP Collider, at the four detectors ALEPH, DELPHI, L3 and OPAL. In August 2000, the physicists working on the ALEPH experiment got strong hints for the possible production of Higgs boson. Three collision events were found which suggested that a Higgs boson was produced along with a Z^0 boson. In these events, both the Higgs and the Z^0 boson decayed quickly to form quarks that cause a spray of particles down in the beginning of November 2000. However, the results obtained at all the four detectors by the groups of investigators were published in 2003 in the Journal Physics Letters B. On 11 March, 2004, a Progress Article appeared in the famous British Journal Nature under the title 'Has the Higgs boson been discovered?' The article authored by Peter Renton, a physicist at the University of Oxford, summarized the search so far made on the discovery of the elusive Higgs particle.

In addition to the direct search being made for the Higgs boson, Renton also mentions about the indirect attempts made in this direction. The elusive particle, incidentally, also manifests itself indirectly through the so-called quantum- loop effects. According to Renton, there is some direct evidence form the results at the LEP Collider that the probable mass of the Higgs boson is about is about 115 GeV/c^2 (c being the velocity of light); the indirect determination also yields a vaule compatible with 155 GeV/c^2. This is about 122 times the mass of proton. Renton points out that the data at LEP "provides only a hint that it could be the elusive Higgs boson." Therefore, the data is yet inconclusive. But, according to Renton, the Large Hadron Collider (LHC) that will hopefully begin its operation in 2007 at CERN should resolve the mystery of whether the Higgs boson exists.

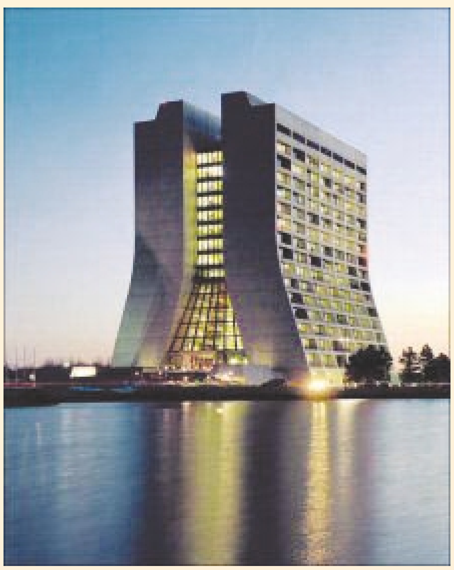
It may be mentioned that the hunt for the Higgs particle is also going on at the Tevatron accelerator situated at the

Lays Hadron Collider (LHC) at CERN under Costrnction

Fermi National Accelerator Laboratory (popularly known as Fermilab) in Illinois. But as, Renton points out in his article published in Nature, a conclusive direct search for the Higgs boson at the Tevatorn seems to be will beyond the projected capabilities of this machine.

It will be both relevant and interesting to quote the views of the celebrated British physicist Stephen Hawking, the author of the best- selling A Brief History of time, on the possible detection of the elusive Higgs particle. According to him, the structure of the universe at its tiniest level is such that the Higgs boson may remain invisible or undetectable. Hawking had staked a bet with Gordy Kane of the University of Michigan that the Higgs boson would not be detected in a major atom-smashing experiment in Geneva. Hawking has already won the bet. However, a second bet still stands between them whether the elusive particle will be discoverd in a similar experiment taking place at the Fermilab in the U.S.

Stephen Hawking



Fermi National Accelerator Laboratory (Fermilab) in Illinois, USA

Whatever may turn out to be the fate of the Hawking's second bet with Gordy Kane, the physicists are nonetheless hopeful that the Large Hadron Collider (LHC) that is under construction at CERN will certainly provide the tell –tale signs for the existence of the Higgs boson. In this mammoth accelerator, instead of electrons and positrons colliding against one another, protons will be smashed against protons.

Meanwhile, an international initiative to detect the elusive particle is also underway. The physicists across the world are preparing to build one of the most ambitious and expensive smashing machine to find the Higgs boson. At a summit meeting in August 2004 in Beijing, twelve experts from countries including Britain, Japan, America and Germany announced that they have agreed on a blueprint to use a gigantic atom- smashing machine called the International Linear Collider (ILC). The Collider, with an anticipated £3 billion price, will not be built in Britain but British scientists are expected to play a leading role in the experiment. The ILC, buried underground away form the vibrations on the surface, would accelerate electrons and positrons form the opposite ends of a 32 km long tunnel at near- light speeds and smash them into each other head-on.

The scientists hope that the resulting cataclysmic explosion of heat, light and radiation will recreate the conditions found in the first few billionths of a second after the Big Bang: and when that happens they hope that the conclusive evidence regarding the existence of Higgs boson will be found.

Reference:

1. Crease, R.P. and Mann, C.C, The Second Creation, Affiliated East-West Press Pvt. Ltd., New Delhi, 1981
2. Renton. Peter, Has the Higgs boson been discovered? Nature, 428, 11 March 2004, pp. 141-144.
3. Higgs, P.W., Broken symmetries, massless particles and gauge Fields, Physics Letter, 12, 132-133, 1964
4. Higgs. P.W. Spontaneous symmetry breaking without massless boson, Physical Review, 145,1156-1163,1966 .
5. ALEPH, DELPHE, 13 are OPAL Collaborations, Search for the Standard Model Higgs Boson at LEP, Physics Letter B, 565, 61-75, 2003.

VIPNET Activities.....(contd. from page 36)

the need to bring about a scientific orientation amongst the people. He felt Vigyan Prasar Network of Science Clubs (VIPNET) was a good medium to do so.

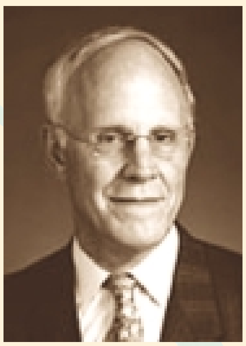
Technical session on Astronomy was led by Shri Arvind C. Ranade, VP describing the Sun and Solar System. Shri Ranade also demonstrated "Earthquake Kit" developed by VP to understand the various aspect of Earthquake. Shri Nimish Kapoor, VP emphasized on supporting low cost activities and gave presentation on "Science Wall Paper". Shri Rajender Singh from Indore gave presentation on scientific explanation of miracles. Shri Jay Singh Khushwaha presented the significance of *Vermi-compost* and its importance in the field of cultivation. Sri R.P.Singh, Multi-Media specialist gave presentation on Multi-Media as a Science Interprise. Vigyan Prasar Publications were also exhibited in the workshop, in which Earthquake Kit was the focus point.

VIPNET workshop for Science Club coordinators and members at Eta during December 30-31, 2004.

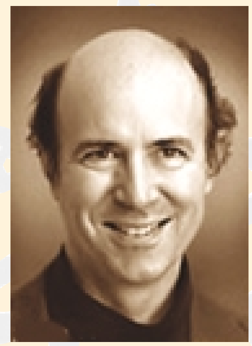
The Strong Force Explained

❑ Biman Basu
e-mail: basu_biman@yahoo.com

The behaviour of all matter in the universe is guided by four fundamental forces of Nature, viz., gravitational force, electromagnetic force, the weak force, and the strong interaction. The gravitational force is weak, but very long ranged. Furthermore, it is always attractive, and acts between any two pieces of matter in the Universe since mass is its source. The electromagnetic force causes electric and magnetic effects such as the repulsion between like electrical charges or the interaction of bar magnets and forms the basis of most electrical and electronic gadgets. It is long-ranged, but much weaker than the strong force. It can be attractive or repulsive, and acts only between pieces of matter carrying electrical charge. The weak force acts only over atomic distances and is responsible for radioactive decay and neutrino interactions. The strong force is very strong, but very short-ranged. It acts only over ranges of order 10^{-13} centimetres and is responsible for holding the nuclei of atoms together.


David J. gross


H. David politzer


Frank wilczek

According to quantum mechanics, the paradoxical *lingua franca* of the atomic world, the forces between particles are transmitted in a kind of game of catch by little bundles of energy. For electromagnetism, the force carriers are quanta of light known as photons. The weak force is carried by the W and Z bosons, which are brothers, of a sort, of the photon.

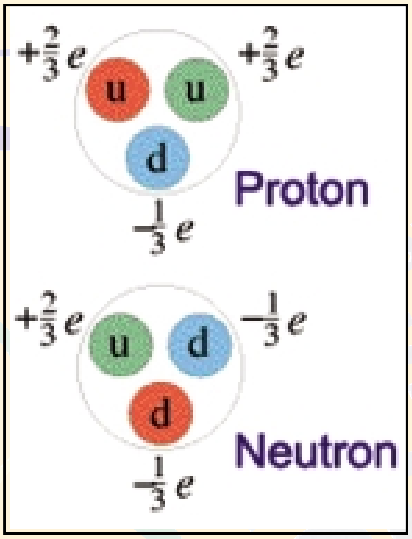
It has been known since the 1960s that the proton and the neutron, the constituents of atomic nuclei, are not single particles but are composites. In 1964 the American physicists Murray Gell-Mann and George Zweig independently suggested that protons and neutrons were made up of smaller particles that Gell-Mann called 'quarks', held together by strong nuclear force. The force between quarks is carried by gluons (from the word 'glue'), which, like photons, lack mass. In contrast to photons, however, gluons also have the property of 'colour charge', consisting of a colour and an anti-colour. This property is what makes the colour force so complex and different from the electromagnetic force.

Six quarks are known, but physicists usually talk about them in terms of three pairs: up/down, charm/strange, and top/bottom. But strangely enough, it was not possible to produce free quarks. Only aggregates of quarks, in combinations of two or three, were known to exist freely as, for example, the proton. Quarks have electric charges which are a fraction of the proton's, $-^1/_3$ or $+^2/_3$, a strange feature which has not yet been explained. Each quark, in addition to an electric charge, also has a colour charge, which, like its electric charge, is quantised; that is, it can only take on certain values. The colour charge of a quark could be red, green or blue, rather like electrical charge can be positive or negative; and just as electrical opposites attract, so combinations of quark colour can make for stable collections of quarks. Of course, here the concept of colour is used as a quantum property, different from the colour that we use in everyday life.

For every quark there is an anti-quark in the same way as the electron has an antiparticle, the positron. Anti-quarks have the colour charges anti-red, anti-blue or anti-green. Aggregates of quarks, which can exist freely, are colour neutral. The three quarks in the proton ('up', 'up', and 'down') have different colour charges so that the total colour charge is white (or neutral). In the same way as electrically neutral molecules can form bonds (through the attraction between their positive and negative parts) the exchange of force between protons and neutrons in the nucleus occurs through the colour forces that leak out from their quarks and force-carrying particles.

Of the four basic forces in nature – namely gravity, electromagnetism, and the weak and strong nuclear forces – the strong force is unusual in that it gets stronger as the quarks get further apart. That is why quarks never appear in isolation, but always in combination. It is as if the quarks were tied together by a rubber band that pulled tauter and tauter as they separated, but went slack when they came together, a notion known as "asymptotic freedom". Protons and neutrons are each made up of a combination of three quarks. Yet experiments with particle accelerators indicated that quarks inside protons seemed to act as if there was no force on them at all; they behaved like free particles.

It was this contradiction that was resolved by three Americans – David Gross of the Kavli Institute for Theoretical Physics at the University of California at Santa Barbara; Frank Wilczek of the Massachusetts Institute of Technology; and David Politzer of the California Institute of Technology, for which they were awarded the Nobel Prize for Physics for 2004. The three scientists discovered a property of the so-called "strong force" which explains why quarks that make up the neutrons and protons could never be seen apart from one another. In two papers published in 1973, one by Gross and Wilczek and the other by Politzer, they came up with a theory to describe the force that holds together quarks, the elementary particles with which nature constructs the neutrons and protons that make up the nuclei of atoms.



Caption of figure: The proton and neutron are made up of different combinations of quarks held together by strong force.

The three scientists found that the strength of the colour force gets weaker as the quarks' energies increase; that is, as the particles get closer together. At sufficiently high energy, the quarks act as though they are 'free'. Studies of high-energy collisions between particles in particle accelerators have now verified in great detail this behaviour of quarks.

Their theory successfully explained why quarks tended to group in threes. It also explained why, paradoxically, the "colour charge" weakens as the quarks move together and strengthens when they move apart. Their work paved the way for a theory known by the fanciful-sounding name 'quantum chromodynamics', or QCD, which helps us understand the structure of protons, neutrons, and similar particles. Quantum chromodynamics is an important part of the 'Standard Model' of particle physics that explains what the world is and what holds it together and explains all the forces of nature except gravity. It may also, in the long run, help physicists find a single unified theory of nature.

Cinnamon.....(contd. from page 29)

carminative, antiseptic, antifungal, anti-viral, blood purifier, and digestive aid. Cinnamon is considered to be mildly carminative and used to treat nausea and flatulence. It is also used alone or in combination to treat diarrhea. The oil in cinnamon is a type of phenol, which is anti-fungal and anti-bacterial, and is said to slow meat to spoil, so its use as spice for meat dishes, especially in warmer climates seems sensible. However, principal pharmacological use today is as an aromatic to cover the disagreeable taste of other drugs.

Yet, cinnamon may hold out some promise. Studies have indicated that intake of cinnamon probably reduces serum glucose, triglyceride, LDL cholesterol, and total cholesterol in people with type 2 diabetes and suggest that the inclusion of cinnamon in the diet of people with type 2 diabetes will reduce risk factors associated with diabetes and cardiovascular diseases. However, further investigations are required for conclusive assertion. Another study reports that chewing-gum laced with cinnamon oil reduces by more than 50 percent the concentration of anaerobic bacteria in the saliva. Microbiological analysis showed that it was particularly effective against anaerobic bacteria residing at the back of the tongue, reducing the population by 43 percent. These bacteria produce volatile sulfur compounds through the putrefaction of proteins and are considered the major contributors to halitosis, or bad breath. When cinnamon is in, Escherichia coli is out; reports another study and cinnamon may be able to help control it in unpasteurized juices.

Cinnamaldehyde is also used as an agricultural fungicide. Cinnamon oil shows promise as a great-smelling, environmentally friendly pesticide, with the ability to kill mosquito larvae, according to a new study published in the *Journal of Agricultural and Food Chemistry*. Despite being widely used in food and pharmacy it is also important in the cosmetic and perfumery industries. Cinnamon oil is also used in preparation perfumes.

The various terpenoids found in the spices essential oil are thought to be the reason for cinnamon's medicinal properties. Eugenol and cinnamaldehyde are two very important terpenoids found in cinnamon. Cinnamaldehyde and cinnamon oil vapors act as potent antifungal agents. The diterpenes found in the cinnamon oil have shown antiallergenic activity. Antibacterial actions have also been demonstrated for cinnamon. The diterpenes in the volatile oil have shown anti-allergic activity as well.

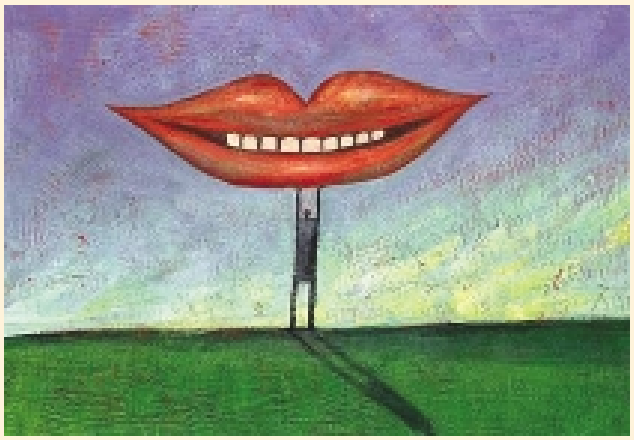
Nonetheless concentrated cinnamaldehyde can irritate the skin and mucous membranes, and typical scented products contain only a few tenths of a percent of this compound. Along with the medicinal effects come the side effects and interactions that medicinal cinnamon causes. Some people may be sensitive or allergic to cinnamon. Also, some people may develop dermatitis after exposure to it. Chronic chewing of cinnamon gum or use of cinnamon flavored toothpaste can cause inflammation of the mouth, and lead to pre-cancerous growth.

Sensitive Teeth

Causes And Cure

❏ Dr. Yatish Agarwal
e-mail: dryatish@yahoo.com

Of the many willing slaves that the body employs, teeth are the most hard working. They munch, crunch, cut and grind with equanimity, till their bite lasts. If it were not for them, chefs surely would go out of business because swallowed whole, food would not taste as good.



But the same teeth, which find no nut too hard to crack, can get awfully fussy at times. Used to taking enormous pressures, they suddenly begin to tingle and ache even when you sip a glass of lemonade, a cold beverage or a hot cup of coffee. Biting into things, be they sweet, sour or plain, can get equally stressful, especially when you cannot pinpoint the location of the pain, and the mirror shows no dental cavities.

Take heed of the alarm bells : The symptoms of a toothache are very characteristic—there is a tingly feeling or sudden flash of pain (when you least expect it!) as a reaction to heat or cold, sweet or sour tastes, or just pressure.

This pain is actually an alarm to indicate that your teeth have developed chinks in their protective armour. Their hard enamel, which keeps the sensitive dentine under complete cover is unable to keep out food particles and fluids. It is this breach in the dental defense that triggers impulses in the watch guard dentine nerves and makes you feel miserable. As soon as these alarm bells ring, take an appointment with the dentist and plan for restoration.

Know what makes the teeth sensitive : Sensitive teeth are a common problem. The reasons to this could be:

- dental caries
- a fractured tooth
- the simple wear and tear due to normal aging, and
- ill-effects of some wrong habits and practices that rob the teeth of their enamel.

The best course is to take preventive steps and guard against such damage. Read on.

Guard against enamel robbers : The use of gritty and badly burnt paddy husks as a *dant manjan* is a common cause of enamel loss. Similarly, chewing of *paan*, *paan-masala*, betel nut and gritty food also causes premature attrition of teeth and exposes the dentine. The irresistible Indian pickle, with its acidic nature, can also pick holes in the enamel, particularly at the neck of the tooth. Beware of these robbers, if you want to keep your dental enamel intact.

Brush teeth gently and correctly : The way you clean your teeth also affects them. For instance, you could have sensitive teeth, if you:

- brush your teeth too hard
- use a hard toothbrush or
- instead of rotary motion of the brush, employ a horizontal one.

These are some of the common mistakes which we all make. The use of a hard bristle toothbrush, extra vigorous cleaning and wrong brushing technique must be

checked from early childhood. Parents must be vigilant about this and must not allow their child to pick up wrong habits.

Improper brushing can also lead to recession of gums. That is, it could result in the gums sinking below the normal line, exposing the dentine and making the tooth sensitive. Thus, good care of gums and enamel right from childhood is your best insurance against sensitive teeth.

Use a soft touch : Always go in for a soft bristle brush as it is easy on your gums and teeth. If you use a hard toothbrush, it may last you longer, but, ultimately, it causes attrition of the teeth, which are much more expensive to repair.

Replace the brush every two to three months, so that it retains its softness and carries out its job properly.

Try desensitizing toothpaste : In case your teeth have already turned sensitive, go to a supermarket and buy yourself a soft bristle toothbrush and special toothpaste for sensitive teeth, such as Thermoseal, Sensoform, Arodent, Pyx or Emoform, and try it out. These special toothpastes contain desensitizing agents capable of insulating the sensitive dentine and prove effective over longer periods of time, provided you stay away from chilled, hot, acidic and sour foods. Just rub the desensitizing toothpaste and leave it on for ten to fifteen minutes before cleaning it up.

See your dentist : In case this prescription does not work, then fix an appointment with your dentist. For all you know, there may be something more than what meets the eye, waiting to be diagnosed and treated.

The more difficult cases often require root canal treatment (RCT). Following RCT, a temporary filling is first made, and if the tooth settles, a permanent filling is completed. The tooth is then restored with the help of a porcelain crown which is fitted on the treated tooth.

The Paintal Era.....(contd. from page 27)

After retirement from ICMR he continued his research work at the DST Centre for Visceral Mechanism in Vallabhbhai Patel Chest Institute. His contribution in recent years included a new method, which he introduced with A. Anand, for measuring *in vivo* the blood concentration of J receptor excitants and showed that they move out of the capillaries through forces of diffusion and not of filtration. He also discovered the principle concerning the relative dilution of multiple solutes in flowing fluids.

Dr Paintal's work won for him several laurels. In 1966 he was elected Fellow of Royal Society of Edinburg and in 1981 he became the first Indian medical scientist to be elected Fellow of Royal Society of London. Other honours he had received were the B. C. Roy Oratorship and Silver Jubilee Award of Medical Council of India, the Rameshwardas Birla National Award, Jawaharlal Nehru Science Award of Government of Madhya Pradesh and Padma Vibhushan. He was elected Fellow of Indian National Science Academy and served as its President for a term. He was President of Indian College of Allergy and Applied Immunology in 1980.

Dr Paintal was elected General President of Indian Science Congress Association for 1984-85 and he presided over the Lucknow Session of Indian Science Congress in 1985. In his Presidential Address he mooted the proposal for the establishment of an exclusive department in Government of India for mountain development. The proposal is yet to take shape.

A non-conformist, Dr Paintal wore no turban and sported no beard. He was always blunt in his comments on men and matters. He did not spare even his fellow scientists who showed scant regard for ethics. A strong votary of values in scientific research he was President of the Society for Scientific Values formed in the 1980s. According to him, the need for ethics was all the more in medical research, as it involved the lives of human beings.

In his plenary lecture at the Jaipur Session of Indian Science Congress in 1994 he dealt extensively with accountability in medical research. Lamenting lack of accountability among scientists in India, particularly in clinical trials of new drugs or formulations, he observed, "Political patronage of unscrupulous scientists is one of the most unfortunate things that afflicts Indian science. Scientists seem to get anything done through lobbying, by maintaining a high level of PRO activities so that they feel unaccountable to anyone. Since self-imposed accountability does not exist in India, as it does in certain western countries, India should develop a system for holding scientists accountable for the suffering of others. However, it would be much more desirable if medical scientists adopted self-imposed accountability". This too is yet to materialize.

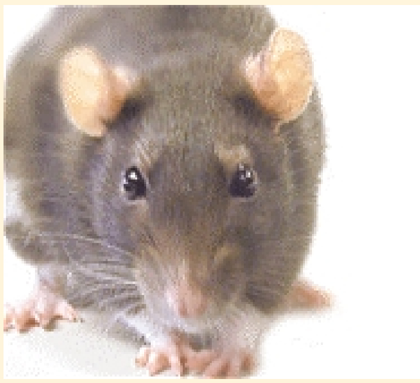
Physically Paintal may be no more but in medical literature the "Paintal era" will remain for ever.

(The author is a Delhi-based senior journalist who was formerly with THE HINDU)

Recent Developments in Science & Technology

Rats show off language skills

The ability to distinguish between two different languages is not unique to humans. New research indicates that rats can manage this as well, making them the third type of mammal with this documented ability.

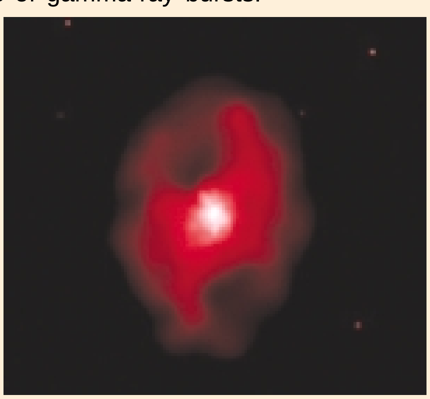


Juan M. Toro and his colleagues at the Parc Cientific de Barcelona in Spain studied 16 rats exposed to sentences spoken in either Japanese or Dutch. The researchers trained the animals to push a lever in response to a specific sentence, and then played sentences in the other language as well. Rats that were trained to respond to Dutch did not push the lever after hearing Japanese and vice versa. Moreover, the creatures could differentiate between Japanese and Dutch sentences that they hadn't previously listened to. The rats' abilities were somewhat limited, however when different speakers were used for each sentence, the animals encountered more difficulty telling them apart.

Source Scientific American ,Jan2005

Voracious Black Hole Generates Most Powerful Explosion Known

Astronomers have discovered the largest explosion in the universe—one that has endured for more than 100 million years and generated as much energy as hundreds of millions of gamma-ray bursts.



NASA's Chandra X-ray Observatory revealed the eruption, located in a galaxy cluster known as MS 0735.6 + 7421. Specifically, the Chandra images show two cavities, each some 650,000 light-years across, that were scoured out by jets of energy emanating from the black hole, which itself may be a billion times the mass of our sun. Announcing the findings in the journal Nature, Brian McNamara of Ohio University and his colleagues posit that this enormous release of energy occurred as matter fell into the black hole: most was gobbled up, but some was spewed back out rather violently. The discovery is unexpected not only because of its record-breaking nature, but because previous work suggested that large black holes don't consume as much matter or grow as quickly as small ones do.

Source : Scientific American.com

Tsunami speed up Earth's rotation

The devastating earthquake that struck the Indian Ocean on 26 December was so powerful that it has accelerated the Earth's rotation, geophysicists have declared. They estimate that the shockwave shortened the period of our planet's rotation by some three microseconds.

The change was caused by a shift of mass towards the planet's center, as the Indian Ocean's heavy tectonic plate lurched underneath Indonesia's one, say researchers at NASA's Jet Propulsion Laboratory in Pasadena, California. This caused the globe to rotate faster, in the same way that a spinning figure-skater accelerates by tucking in her arms.

The blast literally rocked the world on its axis; add Richard Gross and his NASA colleagues. They estimate that Earth now tilts by an extra 2.5 centimeters in the wake of the jolt.

Source : Nature December,2004

Olive oil 'cuts cancer risk'

According to new findings, olive oil can help fight breast cancer. These findings are based on epidemiological studies that show that the Mediterranean diet has significant protective effects against cancer, heart disease and ageing.

Javier Menendez, and his research team of Northwestern University's Feinberg medical school in Chicago, showed in a series of laboratory experiments on breast cancer cells that oleic acid, found in olive oil, dramatically cuts the levels of a cancer-promoting gene called Her-2/neu (also known as erb B-2). High levels of the gene occur in over a fifth of breast cancer patients and are associated with highly aggressive tumors that have a poor prognosis.

Source: Science.com

Compiled by : Kapil Tripathi