R.N. 70269/98
ISSN : 0972-169X

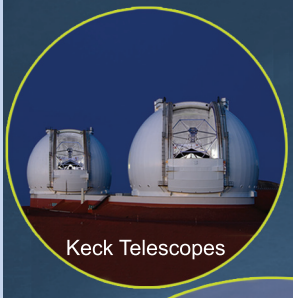
Postal Registration No.: DL-SW-1/4082/09-11
Date of posting: 26-27 of advance month

Vigyan Prasar

DREAM 2047

June 2009 | Vol. 11 | No. 9 | Rs. 5.00

400 Years of Optical Telescopes
Some Important Achievements

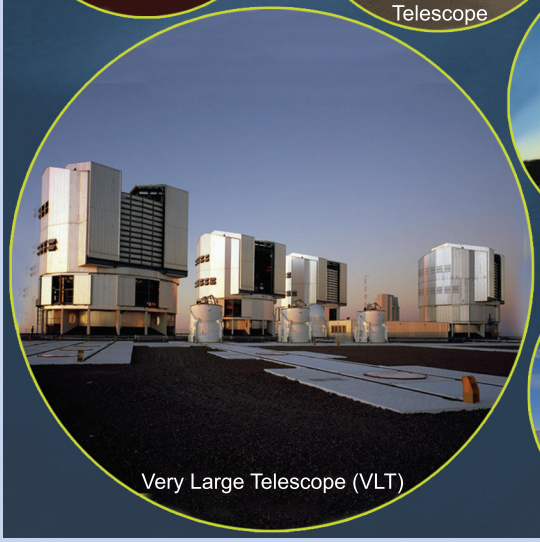

Keck Telescopes

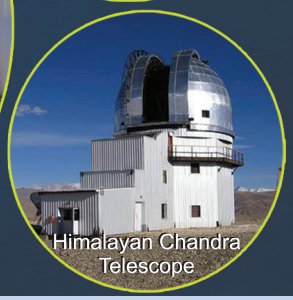

Gemini South Telescope


Gemini North Telescope


Hobby-Ebberly Telescope


Subaru Telescope


Very Large Telescope (VLT)


Himalayan Chandra Telescope

Inside

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

Longest Celestial Drama of the Century

On 22 July 2009, we shall have an opportunity to witness one of the grandest spectacles the nature can offer - the total eclipse of the Sun when the Moon would completely cover the disc of the Sun. It is an event so rare that most people do not get an opportunity to witness it even once in their lifetime. On an average, a total solar eclipse may occur at a particular place on the Earth only once in about 360 years. In addition, such eclipses are notorious in having their tracks of totality very narrow and passing over relatively inaccessible regions of the globe. But, the path of totality of the on 22 July 2009 would pass through a large number of cities and densely populated regions. It will also be the *longest* total solar eclipse of the century, with totality lasting for 6 minutes and 39 seconds at maximum along its path, making it the longest until 2132. Under the most favourable conditions, however, the totality can last for a maximum of 7½ minutes.

How do the eclipses of the Sun take place, anyway? An eclipse of the Sun takes place when the Moon comes between the Earth and the Sun so that the Moon's shadow sweeps over the face of the Earth. This can occur on new Moon day (though not on *every* new Moon day due to the inclination of the Moons orbit). This shadow consists of two parts: the umbra, or the total shadow, a cone into which no direct sunlight penetrates; and the penumbra, or partial shadow, which is caused by light reaching from only a part of the Sun's disc. To an observer within the umbra, the Sun's disc appears completely covered by the disc of the Moon. Such an eclipse is called the *total* solar eclipse. To an observer within the penumbra, however, the Moon's disc appears projected against the Sun's disc so as to cover it partly. The eclipse is then *partial* to the observer. The umbral cone being narrow at the distance of the Earth, the total solar eclipse is observed only over a narrow strip of land or sea over which it passes. The partial solar eclipse, however, can be seen from a large number of places covered by the penumbra.

By a remarkable coincidence, the sizes and the distances of the Sun and the Moon are such that they appear very nearly the same angular size from the Earth. However, their apparent sizes depend on their distances from the Earth. This happens because the Earth revolves in an elliptical orbit around the Sun and the Moon too revolves in an elliptical orbit around the Earth. When the Sun is closest to the Earth, and Moon the farthest, the apparent disc of the Moon is smaller than that of the Sun. The Moon passing over the Sun's disc cannot cover it completely, but leave the rim of the Sun visible. Such an eclipse is called *annular*. In India, we shall have an opportunity witness annular eclipse of the Sun on 15 January 2010 that would be visible in southern parts of the country. Sometimes the Earth misses the umbra but only intercepts the penumbra. Under such circumstances, only *partial* solar eclipse is observed anywhere on the Earth. Moon's disc then does not pass across the centre of the Sun. Incidentally, partial eclipses of the Sun are more frequent than total or annular eclipses.

Why is a total solar eclipse so grand a spectacle? An hour before the totality, there is almost no change in the conditions where a person may be stationed. About twenty minutes before totality, there is a sizeable decrease in the intensity of light. Some three minutes before, the sky darkens considerably. Only a narrow crescent of the Sun can be seen. If you are on a hilltop, and if the eclipse takes place in the afternoon, you may see the umbral shadow of the Moon approaching from the western horizon at a speed of about 800 metres per second (or about 2.5 times the speed of sound). About one minute before the totality, ripples of dark and bright bands, called 'shadow bands', appear to move over a white plain surface. The intensity of light quickly drops in the next few seconds, and this is when the real drama begins. The sunlight shining through the valleys of the Moon, called the Baily's beads, give the appearance of a beaded necklace. And the final flash of light from the Moon's valleys produces a brilliant flare known as the 'diamond ring. Soon after the diamond ring vanishes, the chromosphere or lower atmosphere of the Sun that lies just above the visible photosphere blazes into view, indicating that the totality has just begun. One can then see red or orange jets of fire shooting to millions of kilometres above the surface of the Sun, called prominences. The Sun is now completely hidden behind the Moon and the magnificent pearly white corona flashes into view. Corona is the Sun's outer atmosphere consisting of hot sparse gases that extends to millions of kilometers. It is generally quite feeble, its brightness being comparable to that of the Moon and hence not visible ordinarily due

Contd. on page...23

Editor : **Dr. V. B. Kamble**
Address for correspondence : Vigyan Prasar, C-24, Qutab Institutional Area, New Delhi-110 016; Tel : 011-26967532; Fax : 0120-2404437
e-mail : info@vigyanprasar.gov.in
website : http://www.vigyanprasar.gov.in

Published and Printed by Dr. Subodh Mahanti on behalf of Vigyan Prasar, C-24, Qutab Institutional Area, New Delhi - 110 016 and Printed at Aravali Printers & Publishers Pvt. Ltd., W-30, Okhla Industrial Area, Phase-II, New Delhi-110 020. Ph : 011-26388830-32 **Editor : Dr. V. B. Kamble**

Edward Jenner

Founder of Immunology

☐ Subodh Mahanti
E-mail: subodh@vigyanprasar.gov.in

"Although it was later discovered that the vaccination against smallpox did not last for a lifetime but had to be "refreshed" or "boosted" later, Jenner's treatment not only helped to rid the world of a dreaded disease but established the science of immunization and opened the door to the research by Pasteur, Koch and others looking for cures and immunization against other diseases."

- Ray Spangenburg and Diane K. Moser in *The History of Science in the Eighteenth Century* (1999)

"Jenner's work represented the first scientific attempt to control an infectious disease by the deliberate use of vaccination. Strictly speaking, he did not discover vaccination but (he) was the first person to confer scientific status on the procedure and to pursue its scientific investigation."

- Stefan Riedal in *Baylor University Medical Center Proceedings,* January 2005

Edward Jenner pioneered vaccination. His successful demonstration in 1796 that inoculation with cowpox gave immunity to smallpox was a breakthrough in medical science of immense significance. It saved millions of lives. Jenner is widely recognised as founding father of immunology. It was Jenner who coined the word 'vaccination' from the Latin word 'vaccinia' for 'cowpox.' The celebrated French chemist and bacteriologist Louis Pasteur (1822-1895) adopted it for immunization against any disease. Jenner devised an improved version for preparing a medicine called tartar emetic (potassium antimony tartrate).

We should mention here that Jenner was not the first to observe that infection with cowpox gave immunity to smallpox and he was also not the first to demonstrate inoculation for this purpose. But, as British scientist and writer Francis Galton (1822-1911) said: "In science credit goes to the man who convinces the world, not to the man to whom the idea first occurs." Jenner pursued scientific investigation of vaccination and convinced the world about its efficacy.

Vaccines are the most successful advancement in the history of public health. Vaccines help the body to develop more effective disease-fighting abilities. You are vaccinated means your body has been exposed to weakened or dead forms of the disease-causing agents (viruses or bacteria). They are also called antigens. The body soon identifies these antigens or foreign bodies and makes the immune system act. Actually the vaccine makes the body believe that it has already the full-blown disease. It

Edward Jenner

produces antibodies (which are actually proteins) for circulating in the blood. These antibodies are produced to kill the antigens. Once the antibodies are produced in response to a false alarm caused by the vaccine, they remain in the blood. In future when the body faces a real exposure to the disease it immediately mounts an attack without any time-loss. In other words the body is fully prepared to face the attack. Jenner himself, however, was not aware about the actual mechanism how vaccine worked.

Jenner's interest was not confined to medical science alone. He was an accomplished naturalist and horticulturist. Ornithologists claim that his work on cuckoo and bird migration ranks as outstanding in their field. He studied geology. He was a fossil hunter and he discovered the bones of a plesiosaur, a pre-historic large sea-dwelling reptile in 1819. After the successful demonstration of hot air and hydrogen balloons by Montgolfier brothers in France in 1794, Jenner built his own hydrogen balloon. He launched it twice and it flew 12 miles (about 19.5 km). Jenner played the violin and wrote light verse and poetry.

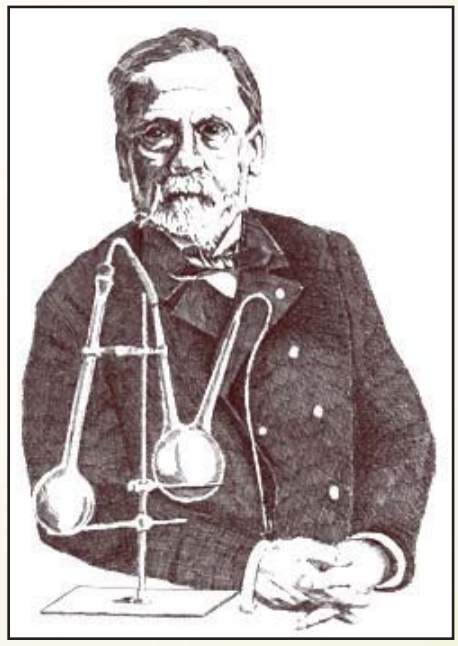
Jenner was a great humanitarian. He did not make any attempt to earn for himself from his discovery. In fact his private practice and other personal affairs suffered greatly due to his single-minded devotion to the cause of vaccination. Jenner built a clinic adjacent to his cottage. It was called "Temple of Vaccinia" where he vaccinated the poor free of cost. At one point of time he was vaccinating almost 300 people daily.

Jenner was ridiculed for his monumental discovery. His critiques, particularly the clergy, thought it was not only repulsive but also heretic (that is, against the teachings of religion) to inoculate someone with material from a diseased animal. In a satirical cartoon published in 1802 persons vaccinated were shown sprouting cow's heads. Jenner was unfazed by such ridicules and he continued to work on vaccination. He was never made a Fellow of the College of Physicians in London because he refused to take a test on the theories of Greek physicians Hippocrates ((460-c.377BC) and Galen (c.AD130-c.200). It was mandatory to pass this test for being admitted into the College, but Jenner did not appear at the test because he thought his work on vaccination should make him eligible for the admission into the College.

Today smallpox is no longer a serious threat. In fact the World Health Organisation (WHO) declared in 1980 that smallpox had been eradicated worldwide. On 8 May 1980, the World Health Assembly announced: "The world and all its people have won freedom from smallpox, which was the most devastating disease sweeping in epidemic from through many countries since earliest times, leaving death, blindness and disfigurement in its wake." This was Jenner's ultimate vindication and memorial. On 30 June 1999, the WHO announced its plan to destroy the last remaining stocks of the smallpox virus.

In the past smallpox was the most dreadful scourge of the human race. In 18th century Europe 400,000 people died annually of smallpox. One-third of those who survived went blind. Most of the survivors were left with disfiguring scars. It used to be called "speckled monster". Smallpox was even responsible for the fall or decline of empires. It is known with certainty when smallpox manifested as a natural disease. Ancient Sanskrit texts of India mention smallpox. Records of smallpox in China go back to around 1100 BC. The Egyptian pharaoh Ramses III (also spelt as Rameses), who died in 1167 BC, is believed to have died of smallpox. His face bears evidence of smallpox. But it appears that smallpox appeared much earlier than these records. It is usually believed that smallpox first appeared around 10000 BC in northeastern Africa where the first agricultural settlements came into existence.

Before the practice of vaccination was developed by Jenner, variolation (or inoculation) with material taken from fresh smallpox sores, was widely adopted. The words "variolation" and "inoculation" are interchangeably used. The word "inoculation" was derived from Latin word *inoculare*, meaning "to graft". The practice of variolation or inoculation was developed independently in many countries. It came to Europe at the beginning of the 18th century. Among those who were variolated



Louis Pasteur

were Empress Marie-Therese of Austria and her children and grandchildren, Frederick II of Prussia, King Louis XVI of France and his Children, and Catherine II of Russia and her son. However, this was practised in Africa, India and China much before the 18th century. However, variolation suffered from two major defects. First, if a virulent dose were administered, a lethal case of smallpox would develop. Second, unless isolated, the inoculated subject was only too likely to start an epidemic among those in contact with him. Unlike variolation, vaccination with cowpox developed by Jenner was safe.

Bronze statue of Jenner in Kensington's Gardens

Edward Jenner was born on 17 May 1749 in a small village of Berkeley, Gloucestershire, England. He was the youngest of six children of his parents. His father Stephan Jenner was a clergyman. Jenner was orphaned at the age of five. He was raised by his oldest brother, who was also a clergyman. Jenner was a keen observer of nature since his childhood.

At the age of 14, he was apprenticed to a country surgeon or apothecary in Sodbury near Bristol. He remained there till the age of 21 and he acquired a considerable knowledge of surgery and medical practice. It has been reported that it was in Sodbury that Jenner heard a milkmaid say, "I shall never have smallpox for I have had cowpox. I shall never have an ugly pockmarked face." In 1770, Jenner went to St George's Hospital in London to study under John Hunter, one of the most eminent surgeons of his time. Hunter was not only one of the most famous surgeons in England but he was also an accomplished biologist and anatomist. Jenner was the first student of Hunter who had decided to rent rooms in his house to students. Hunter was a great experimentalist and he taught Jenner to value experimentation. It is said that Hunter used to repeat William Harvey's advice "Don't think; try" to his student. Jenner came back to his village in 1772 to serve as a local practitioner and remained there till the end of his life except for the period when he served as an army surgeon.

During the outbreak of smallpox in Glocestershire in 1788 Jenner observed that those of his patients who had been infected with cowpox during their work with cattle did not succumb to the disease. This meant that one once infected with cowpox an individual developed immunity to smallpox. Cowpox, an extremely mild disease, was

Jenner's cottage

quite common and it was transferred from the udder of a cow to the hands of its milker. Jenner decided to prove the correctness of his observation by experiment.

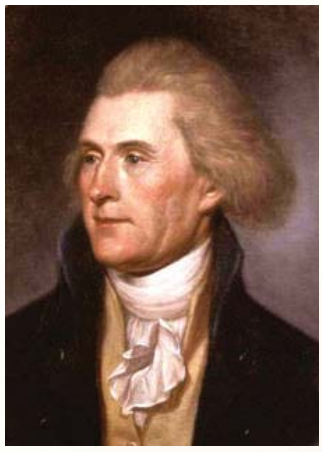
The opportunity to test his prediction about the protective properties of cowpox came when a milkmaid named Sarah Nelms came to consult Jenner about sores on her hand. Jenner immediately recognised it as cowpox and this was confirmed by the patient's statement that one of her cows called Blossom had recently smallpox. The hide of Blossom hangs on the wall of the library at the St George's Medical School to commemorate one of its most famous alumni. Jenner carefully extracted some liquid from Nelms' sores.

On 14 May 1796 Jenner vaccinated an eight-year-old boy named James Phipps with material from the milkmaid's lesion. Phipps' father was a homeless labourer and worked for the Jenners. As Jenner had anticipated, the boy contracted a mild case of cowpox but he quickly recovered. For Jenner the experiment was successful. This experiment proved that cowpox could pass from cow to person and also from person to person. Then to test to his theory that cowpox had protective power Jenner carried out his next experiment. On 1 July 1796, Jenner inoculated the boy with a smallpox serum. It was a dangerous and controversial experiment, as it was a lethal dose of smallpox. However, the boy did not display any sign of being infected with the deadly disease. Jenner repeated his experiment several months later by injecting with yet another lethal dose of smallpox serum. Again the boy did not show any sign of being infected. Similar successful result was later observed with other experimental subjects including his own son.

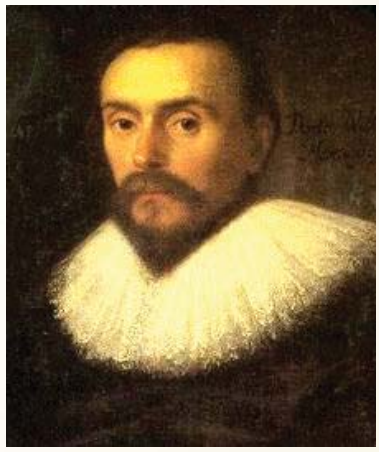
In 1797, Jenner wrote a short paper based on his experiments and observations and sent it to the Royal Society of London for publication, but it was rejected. In 1798, Jenner privately circulated a publication on the subject. It was titled *An Inquiry into the Causes and Effects of the Variolae Vaccine, a Disease Discovered in Some Western Counties of England, particularly Gloucestershire and Known by the Name of Cow Pox*. It had three parts. The first part described Jenner's views on the origin of cowpox as a disease. Jenner believed that it was a disease of horses transmitted to cow. However, this was proved wrong in Jenner's own lifetime. The second part described Jenner's critical observations of the experiments conducted for testing Jenner's theory. The third part contained discussions on the experimental observations and other issues related to smallpox. Jenner himself paid for the printing for this publication.

The significance of Jenner's work was soon recognised, though there were some reservations at the beginning. By 1800, 100,000 people had been vaccinated worldwide. In 1802 Jenner was awarded 10,000 pounds by the House of Commons for continuing his work in vaccination. A Society called Jennerian Institution was established in London in 1803. Jenner himself became associated with the society, the objective of which was to eradicate smallpox. This society was later upgraded to the National Vaccine Establishment. In 1806, he was given another 20,000 pounds by the British Government for continuing his work. In 1804, he was honoured by the Emperor of France Napoleon Bonaparte (1769-1821), who made vaccination compulsory in the French army. Napoleon held Jenner in high respect as evidenced by the fact that the Emperor released several Englishmen who had been jailed in France in 1804 at the request of Jenner. Thomas Jefferson (1743-1826), the President of the USA, was an active practitioner of vaccination. In 1806,

James Phipps, the first person ever to be vaccinated



Thomas Jefferson



William Harvey

Napoleon Bonaparte

James Cook

Jefferson wrote to Jenner: "Future generations will know by history only that the loathsome smallpox existed and by you have been eradicated."

Jenner was a keen naturalist. He developed a special interest in birds. He studied the unusual brood-parasite nesting of the cuckoo. In 1787, Jenner observed that the newly hatched cuckoo rather than the adult cuckoo (as it was to be believed till then), was responsible for removing the other eggs and newly-born chicks from the nest. Jenner showed that newly hatched cuckoo could do it because of an anatomical adaptation in the form of a depression on the back. The depression disappears after 12 days of hatching. With the help of this depression newly-hatched cuckoo cupped eggs and other chicks to push them out of the nest. He published his findings in the *Philosophical Transactions* of the Royal Society in 1787. Jenner's observations were proved beyond doubt in the 20th century when photography became available. It was Jenner who first showed that some birds migrated rather than hibernated during winter. In 1823, the year in which he died, Jenner presented his findings on migratory birds in a paper entitled "Observations on the Migration of Birds" to the Royal Society of London. He classified the zoological specimens that the great British explorer James Cook (1728-1779) brought back from his first voyage of discovery to the Pacific. He did it so well that he was invited by Cook to join him as naturalist on his second voyage. However, Jenner declined the offer in favour of a medical career.

Jenner's works included "An Inquiry into the Causes and Effects of the Variolae Vaccine" (1798), "Further Observations on the Variolae Vaccine "(1799), "A Continuation of Facts and Observations Relative to the Variolae Vaccine (1800) and The Origin of the Vaccine Inoculation (1801).

Jenner was elected a Fellow of the Royal Society of London in 1789, even before his discovery of smallpox vaccination. In 1792, Jenner was awarded MD by St. Andrews University, solely based on his experience. In 1808, he became a founder member of the Medical and Chirurgical Society, which later became the Royal Society of Medicine. He was appointed Physician Extraordinary to King George IV and was made Mayor of Berkeley, and Justice of Peace. Jenner's house in Berkeley, Gloucestershire was converted into a museum in 1985. A statue was erected in Trafalgar Square, which was later moved to Kensington Gardens. A statue made by Robert William Siever was erected in the nave of Gloucester Cathedral. St. George's Hospital, University of London has named one of its wings after Jenner. Gloucestershire Royal Hospital has a ward named after Jenner.

Jenner withdrew himself from the public life in 1815 after the death of his wife. He died on 26 January 1823. Among the mourners was James Phipps, the first person ever to be vaccinated.

References

1. Spangenburg, Ray and Diane K. Moser, *The History of Science in the Eighteenth Century*, Hyderabad: Universities Press (India) Limited, 1999.
2. Riedel, Stephan, Edward Jenner and the history of smallpox and vaccination, *Baylor University Medical Center Proceedings*, Vol.18, No. 1, pp.21-25, 2005 (available on the Internet)..
3. Parthasarthy, R., *Paths of Innovators in Science, Engineering and Technology*, Vol.2, Chennai: East West Books (Madras) Pvt. Ltd.,2003.
4. Basu, Biman, *Science 366: A Chronicle of Science and Technology*, Hyderabad: Universities Press (India) Limited, 2008
5. *A Dictionary of Scientists*, Oxford: Oxford University Press, 1999.
6. *The Cambridge Dictionary of Scientists* (2nd Edition), Cambridge: Cambridge University Press, 2002.
7. The Global Eradication of Smallpox: Final Report of the Global Commission for the Certification of Smallpox Eradication, Geneva: World Health Organization, 1980.
8. *Chambers Biographical Dictionary*, New York: Chambers Harrap Publishers Ltd., 1997.
9. Available sources on the Internet.

(The article is a popular presentation of the important points on the life and work of Edward Jenner in the existing literature. The author has given the sources consulted for writing this article. However, the sources on the Internet are numerous and they have not been individually listed. The author is grateful to all those authors whose works have contributed to writing this article.)

400 Years of Optical Telescopes: Some Important Achievements

Utpal Mukhopadhyay

The year 1609 marked the beginning of a new era in the field of astronomy and astrophysics. In that eventful year, famous scientist Galileo (1564-1642) turned his optical telescope for the first time towards the sky. Four centuries have elapsed since that historic moment. In these four hundred years, innumerable scientific achievements have been accomplished by the use of telescopes. Out of them, only a handful of major discoveries are presented here to offer a glimpse of the development of scientific ideas made possible through the use of the telescope.

Lippershey and Galileo

Dutch glass-maker Hans Lippershey (also called Lipperhey) constructed the first optical telescope by using a combination of a convex and a concave lens. But, due to other contenders like Sacharias Janssen, the Dutch Government never granted a patent to Lippershey. Anyway, Lippershey never used his telescope for observing celestial bodies; his telescope was used mainly for spying and warfare activities. On receiving the news of this discovery and after learning the description of the instrument from travellers, Galileo in Italy built himself a telescope of magnification three (3×) in the middle of 1609. Then, in August 1609, he presented a telescope of magnification eight (8×) to the Senate of Venice. In October or November of the same year Galileo was successful in constructing a telescope of magnification twenty (20×), which he used for observing celestial bodies. Incidentally, the name 'telescope' was used for the first time by Prince Frederick Sesi in 1611 during a demonstration of the telescope by Galileo in Venice.

Galileo's important observations

In December 1609, using his powerful telescope, Galileo made four significant observations, viz., mountains and craters on the Moon, four satellites – Ganymede, Callisto, Io and Europa – of Jupiter (now known as the Galilean satellites after Galileo), phases of Venus, and individual stars in the Milky Way. The first of these observations revealed that the surface of the Moon was not at all smooth as it appears to be, while his second observation dispelled the idea that all celestial bodies revolve around the Earth, as believed at that time. The third observation provided strong evidence in favour of the heliocentric model of Copernicus, and his fourth observation showed that the Milky Way is composed of a multitude of stars. In March 1610, Galileo published the results of his observations in the form of the book *Sidereus Nuncius* (The Starry Messenger). In 1613, he published another book on his observations of sunspots. It may be mentioned here that Galileo used a refracting telescope (or refractor) for his observations. Lenses are used in refractors whereas Isaac Newton (1642-1727) constructed the first reflecting telescope in 1668 by replacing the objective lens by a mirror.

Discoveries in planetary science

From very early days of civilisation, five planets visible to the naked eye (Mercury, Venus, Mars, Jupiter and Saturn) and the Earth were known to humans. Uranus, the seventh planet of the solar system, was discovered accidentally during comet search by William Herschel (1738-1822) in 1781. In honour of King George III, Herschel first named the planet 'Georgium Sidus' (Star of George). The name Uranus was given by German astronomer Johann Elert Bode.

The first day of the year 1801 saw the discovery of the first asteroid, Ceres, by Italian astronomer Giuseppe Piazzi (1746-1826) and the famous German mathematician Carl Friedrich Gauss (1777-1855) calculated its orbit. Three more asteroids – Pallas, Juno and Vesta – were discovered in the years 1802, 1804 and 1807 respectively. Perturbations noticed in the orbit of Uranus hinted at the presence of a celestial body beyond the orbit of Uranus. This led to the discovery of the eighth planet Neptune in 1846 by John Couch Adams (1819-1892) and Johann Gottfried Galle (1812-1910). Pluto, which until recently was regarded as planet, was discovered by Clyde Tombaugh (1906-1997) in 1930.

In 2006, Pluto was stripped of its planetary status after the discovery of a new type of objects known as Kuiper Belt Objects (KBO). It may be mentioned here that in 1949-50, the American astronomer Gerhard Kuiper (1905-1973) proposed the existence of a disc-shaped region extending from just inside the orbit of Neptune to far beyond the orbit of Pluto. This region is known as the Kuiper Belt. Large celestial bodies lying in this region are called Kuiper Belt Objects (KBO) while the smaller ones are known as short-period comets. The first KBO, 1992 QB1 was discovered by Jane Luu and David Jewitt in 1992 using the Keck telescopes in Hawaii. Three more KBOs, viz., KX 76 (diameter 885 km), Quaoar (diameter 1,280 km) and Sedna (diameter 1,800 km) were discovered in 2001, 2002 and 2004 respectively. Although these discoveries rang alarm bell for Pluto, it still remained a planet because all of them were smaller than Pluto (diameter 2,320 km). However, the discovery of the KBO 'UB 313' or '136199 Eris' in July 2005 by Michael Brown of California Institute of Technology sounded the death knell for Pluto, as the newly discovered KBOs were slightly larger than Pluto. Subsequently, in 2006, Pluto was relegated to 'dwarf planet' status by the International Astronomical Union. At present, Pluto is regarded as a 'Plutoid.

As early as in 1659, Christiaan Huygens (1629-1695), using a powerful

telescope, discovered the true nature of the rings of Saturn. Until 1977 Saturn was the only planet known to have a ring system. Then in 1977, ground-based observations by three separate groups discovered five rings of Uranus. J. C. Bhattacharya, the Ex-Director of the Indian Institute of Astrophysics, Bangalore, was the team leader of one of the three groups which made the discovery.

Stellar, galactic and extragalactic astronomy and astrophysics

With the advent of the telescope, stellar astronomy was revolutionised. Now we know that a large number of stars are binary stars. When two stars are entangled in the same gravitational system, they are called binary stars or double stars. There are various types of binary stars such as visual binary, spectroscopic binary and eclipsing binary stars. The first visual binary star Mizar (z UMa) was discovered as early as 1650 whereas the first eclipsing binary star Algol (b Persei) was discovered in 1782 by a deaf and dumb amateur astronomer J. Goodricke (1764-1786). Famous astronomer E. C. Pickering (1846-1919) discovered the first spectroscopic binary star z UMa A. Distance measurements of nearby stars were also possible by the use of telescope. Using the method of trigonometric parallax, distances of the stars a Centauri, a Lyrae and 61 Cygni were independently measured by Thomas Henderson, Wilhelm Struve and Friedrich Wilhelm Bessel around 1835.

Galileo is said to have remarked that man would never be able to know the internal constituents of stars. But that comment was proved wrong when spectral lines of various elements found on Earth were detected in the spectra of stars as well. It is well known that the element helium was found in the spectrum of the Sun by Sir Norman Lockyer (1836-1920) before it was discovered on Earth. Joseph Fraunhofer (1787-1826) detected dark lines in the solar spectrum in 1814. In 1859, when Gustav Kirchhoff (1824-1887) presented his famous laws regarding spectrum analysis then the meaning of the different lines in the solar and stellar spectra became clear. As a result, spectral classification of stars began and the subject of stellar astrophysics made its entry into the scientific arena.

Shortly after the discovery of Kirchhoff's law, the Italian astronomer Pietro Angelo Secchi developed the first system of stellar classification: the five Secchi classes, during 1863-68. Afterwards, during 1874-1895, German astronomer Hermann Karl Vogel made an attempt to classify the stars from the point of view of stellar evolution. All these early efforts culminated into the famous Harvard spectral classification – the result of tireless works of Edward C. Pickering, Williamina Fleming, Antonia Maury, Annie Jump Cannon and others. The physical explanation of spectral classification of stars came from *The Theory of Thermal Ionization* presented by Indian scientist M. N. Saha (1893-1956) in 1920. It became clear that Harvard spectral classification was nothing but a classification of stars according to their surface temperatures.

After invention of the telescope, comet hunting became very popular among professional as well as amateur astronomers. For instance, William Herschel and his sister Caroline were famous comet hunters. In fact, Herschel initially considered Uranus as a comet. For this reason, in early days of its discovery, Uranus was also known as 'Herschel's comet'. During his search for comets, Charles Messier (1730-1817) noticed that nebulous-looking celestial objects were often confused as comets. For removing this difficulty in comet-hunting, Messier published a catalogue of celestial objects in 1781. Messier's work was extended in a more systematic manner, which resulted in the publications of John Herschel's General Catalogue (GC) in 1864; Dreyer's New General Catalogue (NGC) in 1888; First Index Catalogue (IC I) in 1895; and Second Index Catalogue (IC II) in 1908. After publications of these catalogues, it was found that some of the objects of Messier catalogue were actually nebulae while others were galaxies, star clusters, etc. At present, celestial objects included in New General Catalogue (NGC) are designated by their NGC number whereas those included in Messier catalogue are denoted by M number. For instance, NGC 224 (224th object in the New General Catalogue) and M 31 (31st object in Messier catalogue) both indicate the Andromeda galaxy.

Telescopic observation by Harlow Shapley (1885-1972) showed for the first time that our Sun is not at the centre of the Milky Way. He showed in 1918 that the Sun is near the edge of our Galaxy and dispelled a long standing misconception regarding the position of the Sun. Morphological classification of galaxies by Edwin Hubble (1889-1953) became possible also due to his telescopic observation of galaxies during 1924-26.

General relativity and cosmology

Albert Einstein (1879-1955) published his 'General Theory of Relativity' (GTR) in 1915. One of the predictions of GTR was the bending of light due to the presence of a nearby massive body. That prediction was confirmed during the total solar eclipse in 1919, when two teams (one at Sobral in Brazil and another at the Principe island) detected the bending of Sun-grazing starlight coming from the Hyades star-cluster.

Telescopic observation by Hubble using 100-inch Hooker Telescope (the then largest telescope of the world) on Mount Wilson gave birth to modern cosmology. Hubble discovered that the Universe is not at all static (as supposed by many scientists including Einstein); rather it is in an expanding state. Observation of recession of galaxies prompted Hubble to establish his famous velocity-distance law (known as Hubble's law), which is a pillar of cosmological theories. In fact the Big Bang theory, the most accepted theory of modern cosmology, rests entirely on 'Theory of Expanding Universe'.

The penultimate years of the last century ushered in a new era in cosmology. Telescopic observations of a particular type of supernovae, viz., type 1a supernovae, have revealed that the Universe is not only expanding but the expansion is also accelerating. This signifies a paradigm shift from 'Expanding Universe' to 'Expanding

Accelerating Universe'. Some exotic type of entity, called 'dark energy', is supposed to be responsible for this observed acceleration. So, telescopic study is responsible for the origin of the idea of dark energy. It may be mentioned here that the discovery of another unknown constituent of the Universe, viz., 'dark matter', became possible also through telescopic observation.

Early use of telescope – Indian perspective

First use of telescope on Indian soil was done not by any Indian, but by an Englishman named Jeremiah Shackerley. In 1651, Shackerley observed the transit of Mercury from Surat in India. The very next year, Shackerley observed the comet C/1652 Y1. Perhaps it was the first telescopic observation of a comet from Indian soil. But Shackerley's observation had no scientific value because he merely observed the phenomena without noting down specific timings of the occurrences. Then in 1689, a Jesuit, Father Risseau, was instructed by the French Academy of Sciences, Paris to carry out astronomical observations of the comet C/1689 X 1 from Pondicherry in India during December 8-21. During that observation, Risseau discovered that α Centauri is a double star. This was the first recorded astronomical discovery made from Indian soil. Incidentally, α Centauri was the second double star to be discovered. Apart from these observations, Risseau determined the latitude of Pondicherry and by observing the occultation of a satellite of Jupiter he also calculated the longitude of that place.

Although Shackerley and Risseau initiated telescopic observations in India in the seventeenth century, regular telescopic observations in India started more than a hundred years later. Indian king Sawai Jai Sing established five observatories in India, but did not pay any attention to modern astronomical tools. The first modern astronomical observatory was established in India by an Englishman William Petrie in his own residence in the year 1786. Petrie acted as a Governor of Madras for a few months. According to his wish, East India Company took over that observatory in 1990 and after two years it was shifted to Nungambakkam. After this initiative by Petrie, many other observatories were established in India and astronomical activities gained momentum.

Some large optical telescopes of the world

(1) Keck Telescopes

These are twin telescopes with 9.8-metre primary mirrors, located just 100 metres apart, at a height of 4,025 metres on the dormant volcano Mauna Kea in Hawaii Island. Incidentally, at present 13 telescopes of 11 countries are placed at Mauna Kea.

(2) Hobby-Ebberly Telescope

This telescope is situated at McDonald Observatory, near Fort Davis, Texas, USA. It has a mirror diameter of 9.2 metres.

(3) Subaru Telescope

The Subaru telescope of the National Astronomical Observatory of Japan is located on Mauna Kea in Hawaii, just 500 metres away from the Keck telescopes. The diameter of its mirror is 8.2 metres.

(4) Very Large Telescope (VLT)

Four telescopes, each with a mirror diameter of 8.2 metres, are situated at Cerro Paranal, 600 km north of La Silla in Chile, at an altitude of 2,635 metres.

(5) Gemini North Telescope

The mirror diameter of this telescope, located on Mauna Kea in Hawaii, is 8.1 metres.

(6) Gemini South Telescope

It is the twin of Gemini North Telescope, situated in the southern Atacama Desert in South America at an altitude of 2,737 metres.

(7) The Himalayan Chandra Telescope

India has the unique distinction of having the highest altitude telescope of the world. It is situated in the remote village of Hanle in Ladakh at an altitude of 4,517 metres. Named 'Himalayan Chandra Telescope', it has a mirror diameter of 2 metres. This telescope is operated from Indian Institute of Astrophysics, Bangalore which is situated 2,000 km away from the observatory.

Final remarks

During last 400 years since Galileo's observation, human civilization has witnessed an incredible development in science and technology. What was once used as a spy-glass has become a formidable tool in the hands of astronomers. More and more advanced astronomical telescopes have been built throughout the world to facilitate better astronomical observations. Apart from purely scientific endeavours, they have also been used for popularisation of astronomy, eradication of superstitions, etc. Nowadays astronomers are equipped not only with optical telescopes but also with radio telescopes, X-ray telescopes, gamma-ray telescopes, and much more. Some telescopes like the Hubble Space Telescope (HST) and the Spitzer Telescope have been placed in space to overcome the disturbances due to the Earth's atmosphere. Already a lot of information has been provided by all these telescopes and more are yet to come in future. mankind will be waiting for that.

References

1. Ferris, Timothy: *Coming of Age in the Milky Way*; Affiliated East-West Press Pvt. Ltd., 1990.
2. Abhyankar, K. D.: *Astrophysics, stars and galaxies*; Universities Press, 2001.
3. Kochhar, R. K. and Narlikar, J. V.: *Astronomy in India: A Perspective*; INSA Publication, 1995.
4. Kochhar, R. K.: Transit of Mercury 1651, The Earliest Telescopic Observation in India; *Indian Journal of Science*, 24 (3), 186-192, 1989.
5. Kochhar, R. K.: Secondary Tools of Empire, Jesuit Men of Science in India in '*Discoveries, Missionary Expansion and Asian Cultures*' (ed. Teotonio De Souza), Concert Publishing Co., New Delhi.
6. Editorial: *Dream 2047* (Vigyan Prasar); December, 2008.
7. Bhattacharya, Sandip: 'The New Millennium Wonder Scopes'; *Dream 2047* (Vigyan Prasar); May 2005.

Utpal Mukhopadhyay

Satyabharati Vidyapith, P. O. Nabapally, Dist. North 24, Parganas, Kolkata – 700 126

Vanquishing Breast Cancer:
Early detection holds the key

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

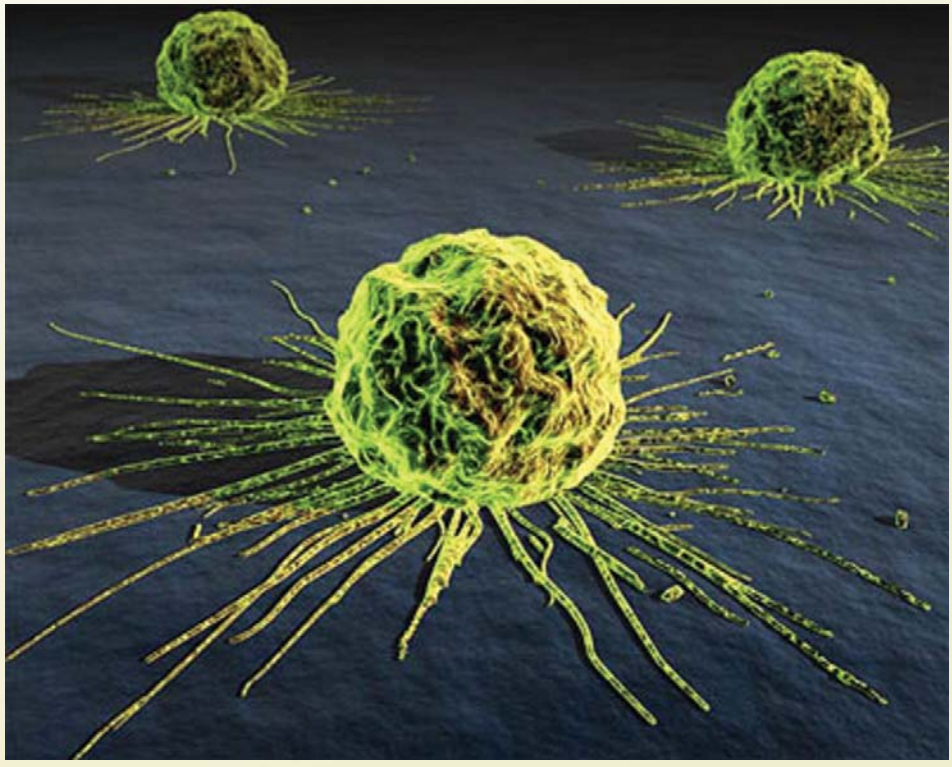
> Nobody knows what the cause is,
> Though some pretend they do;
> It's like some hidden assassin
> Waiting to strike at you.
> Childless women get it,
> And men when they retire;
> It's as if there had to be some outlet
> For their foiled creative fire.
>
> –W. H. Auden in
> *Dr. Thomas on Cancer in Miss Gee*

You may find this hard to believe, yet the plain fact is breast cancer can strike both men and women. Women are however about 100 times more likely to develop the disease than men. Most cancers in female breasts form shortly before, during, or after menopause, with three-quarters of all cases being diagnosed after age 50. Generally, the older a woman is, the greater is her likelihood of developing breast cancer.

Worldwide, breast cancer is the most common cancer among women. The disease is also on the rise in India, and today, it tops all other female cancers in several major cities of this country.

Varieties of breast cancer

A disease characterised by the growth of malignant cells in the mammary glands, almost all cases of breast cancer begin in the glandular tissues that either produce milk (lobular tissue) or provide a passage for milk (ductal tissue) to the nipple. Cancers of these tissues are called lobular carcinomas and ductal carcinomas. Since these tissues are glandular, both cancers are called adenocarcinomas. The most common type of tumour, called infiltrating ductal carcinoma, is a single hard, barely movable lump. This type of tumour accounts for about 70 percent of all cases. Fewer than 15 percent of all cases are lobular carcinomas.



There are several other types and subtypes of tumour classified and named according to several criteria, including their outward appearance, cellular composition, cellular origin, and activity.

Paget's disease is an uncommon type of breast cancer that begins at the nipple and initially causes a burning, itching, or tender sensation. Eventually the lesion becomes enlarged, cracks, oozes, and forms crusts.

Inflammatory carcinoma is a rare type of breast cancer that results in swelling and reddening of the affected area. The area then becomes purplish, and the skin is hot, with the nipple usually becoming crusted and retracted.

Spread of the disease

When breast cancer spreads outside the breast, cancer cells are often found in the lymph nodes under the arm. These are named the axillary lymph nodes. If the cancer has reached these nodes, it may mean that cancer cells have spread to other parts of the body – other lymph nodes and other organs, such as the bones, liver, or lungs – via the lymphatic system or the bloodstream. This spread is called metastasis and it makes the disease a more difficult foe to beat.

Risk factors for breast cancer

The risk of breast cancer increases gradually as a woman gets older. This disease is less common in women under the age of 35. All women age 40 and older are at risk for breast cancer. However, most breast cancers occur in women over the age of 50, and the risk is especially high for women over age 60.

The exact causes of breast cancer are largely unknown, but both environmental

and genetic factors are involved. The following conditions place a woman at increased risk for breast cancer:

Genetic factors : Changes in certain genes (BRCA1, BRCA2, and others) make women more susceptible to breast cancer. In families in which many women have had the disease, gene testing can show whether a woman has specific genetic changes known to increase the susceptibility to breast cancer. This information can come in useful in early detection of the disease in women who have the genetic alterations.

Family history : A woman's risk for developing breast cancer increases if her mother, sister, daughter, or two or more other close relatives, such as cousins, have a history of breast cancer, especially at a young age.

Personal history of breast cancer. : Women who have had cancer of the breast face an increased risk of getting breast cancer again. The disease may occur in the other breast, or the previously diseased one which did not go under the scalpel.

Late childbearing : Women who had their first child after the age of 30 have a greater chance of developing breast cancer than women who had their children at a younger age.

Menstrual history : Women who started menstruating at an early age (before age 12), experienced menopause late (after age 55), never had children, or took hormone replacement therapy or birth control pills for long periods of time are also at a somewhat increased risk for developing breast cancer. Each of these factors increases the amount of time a woman's body is exposed to oestrogen. The longer this exposure, the more likely she is to develop breast cancer.

Certain breast changes : Having a diagnosis of atypical hyperplasia or lobular carcinoma *in situ* or having had two or more breast biopsies for other benign conditions may increase a woman's risk for developing cancer.

Breast density : Women of age 45 and older whose mammograms show at least 75 percent dense tissue are at increased risk. Dense breasts contain many glands and ligaments, which make breast tumours difficult to "see", and the dense tissue itself is associated with an increased chance of developing breast cancer.

Past history of radiation therapy : Women whose breasts were exposed to radiation during their childhood, especially those who were treated with radiation for Hodgkin's disease, are at an increased risk for developing breast cancer throughout their lives. Studies show that the younger a woman was when she received her treatment, the higher her risk for developing breast cancer later in life.

In many cases, however, none of the risk factors listed above is found, except the risk that comes with growing older. Also, most women with known risk factors do not get breast cancer. But this is the nearest that research has lead us to as regards to mapping the causes of breast cancer and identifying ways of prevention.

Early detection

When breast cancer is found and treated early, the chances for survival are better. Women can take an active part in the early detection of breast cancer by doing breast self-exams and having regular screening mammograms, if the doctor recommends.

Breast self examination

A once a month breast self-examination can help check for any changes in their breasts. When doing a breast self-exam, it's important to remember that each woman's breasts are different, and that changes can occur because of aging, the menstrual cycle, pregnancy, menopause, or taking birth control pills or other hormones. It is normal for the breasts to feel a little lumpy and uneven. Also, it is common for a woman's breasts to be swollen and tender right before or during her menstrual period. It is important for each woman, therefore, to become familiar with the structure of her own breasts. In this way, she'll be able to recognise any unusual changes that may occur.

Most breast lumps are first noticed by the woman herself, and monthly breast self-exams can prompt this. That can play a key role in early detection of breast cancer. Most breast lumps are not cancerous.

A breast self-exam is a simple three-step process. You just need to spend a few minutes each month to do a complete exam. The best time to carry out the breast self-exam is seven to 10 days from the beginning of menstrual cycle or for post-menopausal women, the same day each month.

You should 'look' and 'feel' for changes in the breasts, such as lumps,

dimpling or skin changes. Here's how you should proceed:

In the bath

You may do this simple manoeuvre anywhere you please! Typically, however, these steps are recommended while you're enjoying a shower.

Start by raising your right arm behind your head.

With your left hand, fingers held flat together, roll and press the breast firmly against the chest wall.

Using a circular motion, feel a small portion of the breast at a time, until the entire breast area including armpit and chest area from collarbone to below breast have been checked. Repeat using firmer pressure.

Now repeat, raising your left arm and checking your left breast with your right hand.

Before a mirror

Position: You may either sit or stand, depending on whatever is more comfortable.

With your arms at your sides, look for changes in your breasts – lumps, thickenings, dimples or skin changes.

Raise your arms above or behind your head, again, looking for the same changes.

Now, with your hands on your hips, press down and tense your chest muscles. This will make any changes more prominent.

Finally, squeeze each nipple gently for any discharge.

Lying down

Lie down on your back. Relax. Feel comfortable.

Then...place a pillow under your right shoulder.

Now simply repeat the process you went through a little earlier, examining your right breast with your left hand.

Move the pillow under your left shoulder and examine your left breast with your right hand.

And that's all there is to it!

If you find a problem, consult your doctor right away.

Mammography

A mammogram is a good tool available for finding breast cancer early, before symptoms appear. It is a special kind of x-ray, which can often detect breast cancer before it can be felt. Also, a mammogram can show small deposits of calcium in the breast. Although most calcium deposits are benign, a cluster of very tiny specks of calcium (called micro calcifications) may be an early sign of cancer.

Although mammograms are the best way to find breast cancer early, they do have some limitations. A mammogram may miss some cancers that are present (false negative) or may find things that turn out not to be cancer (false positive). Also detecting a tumour early does not always guarantee that the patient's life will be saved. Some fast-growing cancers may already have spread to other parts of the body before being detected.

Still, regularly scheduled screening mammograms, together with breast self-exams, offer the best chance of finding and treating breast cancer early. Many studies favour that women in their forties and older should have mammograms on a regular basis, every 1 to 2 years. However, some recent research studies have questioned this strategy, and the best course probably is to go by your doctor's advice. Those at high risk may benefit from regular mammograms, the others could possibly continue with breast self-exams.

Watch out for these symptoms

Early breast cancer usually does not cause pain. In fact, when breast cancer first develops, there may be no symptoms at all. But as the cancer grows, it can cause changes that women should watch for:

- A lump or thickening in or near the breast or in the underarm area;
- A change in the size or shape of the breast;
- Nipple discharge or tenderness, or the nipple pulled back (inversion) into the breast;
- Ridges or pitting of the breast—the skin looks like the skin of an orange; or
- A change in the way the skin of the breast, areola, or nipple looks or feels – for example, warm, swollen, red, or scaly.

A woman should see her doctor for any of these symptoms. It is more than likely that these signs may not be due to cancer, but it is important to rule that out so that the problem can be diagnosed and treated as early as possible.

Recent Developments in Science and Technology

□ Biman Basu
Email: bimanbasu@gmail.com

The riddle of methane on Mars

Ever since the Italian astronomer Giovanni Schiaparelli described what he saw on Mars to be 'canals', human curiosity about possible life on the Red Planet has remained high. With the advent of space probes sporadic systematic search has been going on to find signs of life on Martian soil, but without success. But there is evidence of a warmer and wetter past – features resembling dry riverbeds and minerals that form in the presence of water indicate water once flowed through Martian sands. Since liquid water is required for all known forms of life, scientists wonder if life could have risen on Mars, and if it did, what became of it as the Martian climate changed. A recent finding has raised interesting possibilities about the presence of life on Mars. A team of NASA and university scientists led by Michael J. Mumma of NASA Goddard Space Flight Center recently reported the discovery of huge release of methane gas into Martian atmosphere. The discovery was made after careful measurement of methane and water vapour simultaneously over several Mars years with NASA's Infrared Telescope Facility and the Keck telescope, both at Mauna Kea, Hawaii. The measurements were made using high-dispersion infrared spectrometers at three ground-based telescopes. The researchers detected methane in extended plumes, one of which released about 19,000 metric tons of methane (*Science*, 20 February 2009).

The presence of methane-producing mineral, known as serpentine, on Mars cannot account for the large amounts of methane found on the Red Planet.

On Earth, living systems produce more than 90% of the methane found in the atmosphere; the balance is of geochemical origin. It is the main component of natural gas on Earth. Astrobiologists are interested in methane because organisms release much of Earth's methane as they digest nutrients. Microbes that produced methane from hydrogen and carbon dioxide were one of the earliest forms of life on Earth. However, other purely geological processes, like oxidation of iron, also release methane. According to the researchers, on Mars, methane could be of either origin.

If microscopic Martian life is producing the methane, it likely resides far below the surface, where it is still warm enough for liquid water to exist. Liquid water, as well as energy sources and a supply of carbon, are necessary for all known forms of life. On Earth, microorganisms are known to thrive two to three kilometres beneath the surface, where natural radioactivity splits water molecules into molecular hydrogen (H_2) and oxygen. The organisms use the hydrogen for energy. Some scientists consider it possible that microbes could have survived for aeons below the Martian permafrost layer, where water changes from ice into liquid.

Meanwhile, the journal *Nature* (27 March 2009, doi:10.1038/news.2009.197) has reported the discovery of a methane-producing mineral, known as serpentine, on Mars. The discovery was made by Bethany Ehlmann, a PhD student at Brown University in Providence, Rhode Island, using a spectrometer on the *Mars Reconnaissance Orbiter* to identify two small outcrops of the mineral.

Serpentine arises from another mineral called olivine in a hydrothermal process in which hydrogen gas is produced – a potential energy source for microbes that could in turn produce methane. The conversion of olivine into serpentine also produces methane, without the need for life. However, according to planetary scientists, the

finding of serpentine does not rule out life on Mars today because that depends on whether the presence of serpentine has anything to do with the apparent production of present-day methane.

The final answer may be found after Nasa's *Mars Science Laboratory* (*MSL*) rover, due to launch in 2011 reaches the Red Planet. *MSL* will carry instruments designed to distinguish between carbon in gases produced by biological activity and those with a geochemical origin.

Nickel may be the key to Earth's oxygen

The atmosphere of early Earth is believed to have been rich in water vapour and a mixture of poisonous gases like methane, ammonia, and carbon dioxide. It did not have any oxygen, which appeared only after organisms called cyanobacteria, commonly known as 'blue-green algae' appeared. As the blue-green algae grew in the Earth's oceans, they began to fill the atmosphere with oxygen – an event described as the 'Great Oxidation Event' that occurred some 2,400 million years ago. The oxygen that blue-green algae produced flooded the atmosphere with oxygen and made it possible for other types of organisms to develop. New research now suggests another factor that may have also contributed to the rise in the level of oxygen in Earth's atmosphere, and that factor is a drop in the concentration of the trace metal nickel in sea water. Nickel exists in today's oceans in trace amounts, but was up to 400 times more abundant in the Earth's primordial oceans. Kurt Konhauser, a geomicrobiologist at the University of Alberta in Edmonton, Canada and colleagues report a decline, about 2,700 million years ago, in the oceanic nickel-to-iron ratio, as evident from the study of sedimentary rocks, which they attribute to a reduced flux of nickel to the oceans and which they say is linked to the build-up of oxygen in the atmosphere (*Nature*, 9 April 2009).

Nickel is an important nutrient for a class of bacteria known as methanogens, which produce methane, a gas that reacts easily with oxygen. Billions of years ago, methanogens thrived in nickel-rich seas. The high amounts of methane that this early life form pumped into the environment prevented oxygen level in the atmosphere from increasing because the methane reacted with any oxygen, creating carbon dioxide and water. According to the researchers, the drop in nickel concentration in seawater would have had profound consequences for the survival of the methane-producing bacteria, which in turn would have reduced the methane production and consequent destruction of oxygen in the atmosphere. With less methane around to tie it up, oxygen accumulated in the atmosphere, eventually creating conditions for oxygen-breathing life to dominate.

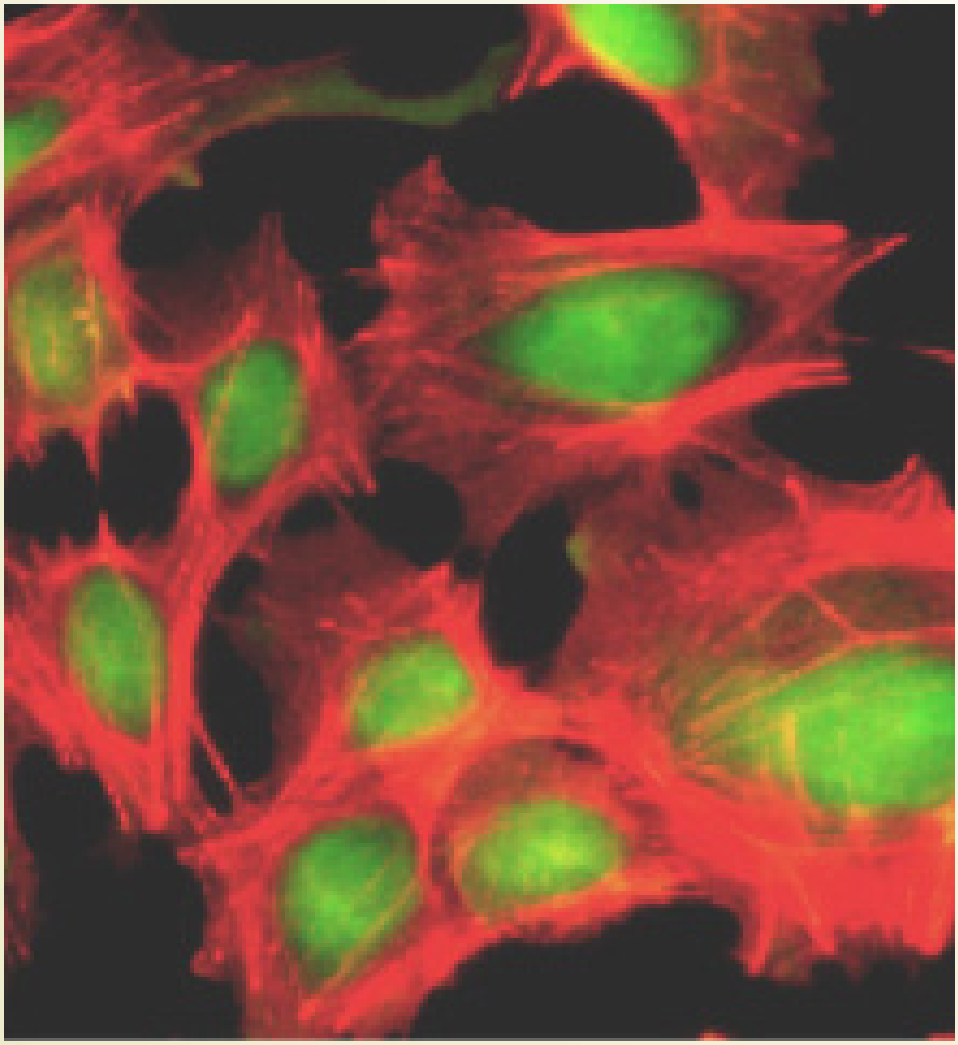
Banded iron formations like this from northern Michigan, USA, contain evidence of a drop in dissolved nickel in ancient oceans. (Credit: Carnegie Institution for Science)

The researchers measured the concentration of nickel deposited in layered sedimentary rocks, called 'banded iron formations' (BIFs) from dozens of different localities around the world, ranging in age from 3,800 to 550 million years. Banded iron formations are unique, water-laid deposits often found in extremely old rock strata that formed before the atmosphere or oceans contained abundant oxygen. As their name implies, they are made of alternating bands of iron and silicate minerals. They also contain small amounts of nickel and other trace elements. The researchers found that nickel levels in the BIFs began dropping around 2,700 million years ago and by 2,500 million years ago was about half its earlier value. "The timing fits very well. The drop in nickel could have set the stage for the Great Oxidation Event," the researchers say.

As for the cause of the drop in nickel, the researchers point to geologic changes that were occurring during the interval. During earlier phases of the Earth's history, while its mantle was extremely hot, lavas from volcanic eruptions would have been relatively high in nickel. Erosion would have washed the nickel into the sea, keeping levels high. The scientists suggest that cooling of the Earth's mantle reduced eruptions of nickel-rich volcanic rock, which meant that less nickel was being weathered from the rocks and dissolving in the oceans.

Heart muscle regenerates

A heart attack is always a scary event not only because the heart is vital for survival but also because it was believed that damaged heart muscles never regenerate. The common belief has always been that cell division in the heart stops after birth. But recent research shows that heart muscle cells continue to divide throughout adulthood; that is, the human heart is capable of at least some self-repair. Using carbon dating to gauge the age of heart cells, scientists have found that a small number of new heart cells are continuously being created throughout a person's life (*Science*, 3 April 2009).



Heart muscle cells (shown above in false colour) can be grown from human embryonic stem cells, but new research suggests the adult heart can grow new cells, too. (Credit: Cellular Dynamics)

Ratan Bhardwaj and his colleagues at the Karolinska Institute in Stockholm, Sweden, used radiocarbon dating, which is normally employed to establish the age of archaeological or geological remains, to work out the age of heart cells and compared it to the chronological age of the person from which they were isolated. To do this, the team took advantage of nuclear tests done during the 1950s and 1960s, which led to a sharp increase of radioactive carbon-14 in the atmosphere. The carbon-14 was captured by plants as CO_2 and then worked its way up the food chain and into the DNA of the human body. After the Limited Nuclear Test Ban Treaty took effect in 1963, carbon-14 levels in the atmosphere dropped, but amounts of the isotope remain in both the environment and humans.

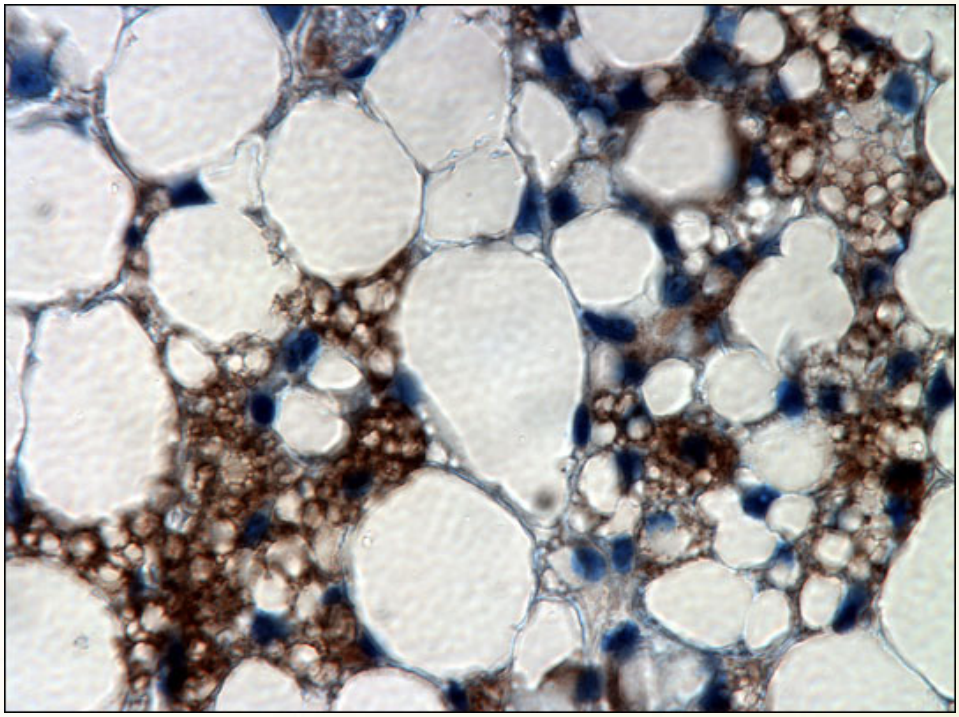
In presence of carbon-14, cells use this radioactive isotope to build DNA when they divide, a phenomenon that the researchers used as a birthmark for new cells. If heart muscles did not regenerate after birth there should be no carbon-14 in the DNA of heart cells of people born before 1955, when the first nuclear bombs were tested. But when the researchers measured carbon-14 levels in the heart tissue of twelve deceased patients aged between 19 and 73 at the time of death, they found elevated carbon-14 even in heart muscle of those who had been born two decades *before* the nuclear tests started, indicating that the radioactive carbon must have been incorporated into heart muscle cells long after birth. Similarly, the carbon-14 levels in the hearts of younger patients did not match the year of their birth but rather indicated a younger age for the new cells.

Using mathematical modelling, Bhardwaj and colleagues have calculated that only 1 percent of cells are typically exchanged per year in young adults. This rate drops to only 0.4 per cent by age 75. This means that a 55-year-old will have rebuilt 45 per cent of his/her heart since birth. Other cells in the heart, such as those that form connective tissue and blood vessels, renew much faster, exchanging about 18 percent every year.

Brown fat can keep you lean

We have all been taught that too much fat is bad. But recent research shows that all fat is not bad. Just like good and bad cholesterol, apparently there are good and bad types of body fat. White fat – considered the 'bad' kind – is a way for the body to store excess energy that accumulates when one consumes more calories than one uses. White fat comes in handy when food is insufficient and the body needs extra energy. But brown fat – the 'good' kind – actually burns excess energy to generate heat.

Scientists have known about brown fat for decades. Small mammals and human infants have deposits of it around their shoulder blades. It makes up about five percent of an infant's total body mass. It generates heat and helps maintain the body's core temperature.



A cross section of fat tissue from a mouse. The large white blobs are white fat cells. The smaller brown circles are brown fat cells, which burn energy to generate heat. (Patrick Seale and Bruce Spiegelman)

Adults have less of it as they age, and until now it was believed that brown fat dwindles with age and becomes physiologically unimportant. But three new studies show that adult humans do have brown fat, which plays an important role in fighting cold and maintaining body weight (*New England Journal of Medicine*, 9 April 2009). More importantly, they point to the possibility of a whole new way to help people lose weight and keep it off.

In one of the studies, a team of researchers from Joslin Diabetes Center in Boston, USA, led by Aaron Cypess, after examining high-tech imaging scans of nearly 1,800 people discovered that almost all adults have small deposits of brown fat around their collarbones and in their necks. Women have twice as much on average as men. But even so, most women have only about 14 grams of brown fat.

Two other studies, which come from the University of Maastricht in the Netherlands and centres in Finland and Sweden, also provide new insights about brown fat. According to the studies, people have less of it as they age; obese people have less of it than lean people; and it is activated by spending even a little time in a chilly room.

The Dutch team studied brown fat activity in 24 healthy young men – 10 of them lean and the others overweight. Study subjects spent two hours in a mildly chilly room at 16 degrees Celsius and then underwent PET scans and CT scans to measure the location and metabolic activity of brown fat deposits. Brown fat showed up as 'hot spots' in the scans of 23 out of the 24 volunteers. The one with no detectable brown fat was the most obese. However, researchers do not know yet whether people become obese in part because they lack brown fat, or whether their brown fat stores go away after they become obese.

The Scandinavian researchers found that when healthy adult volunteers were exposed to chilly temperatures there was a 15-fold increase in the metabolic rate of brown fat in their body. They estimate that if a way could be found to activate the typical person's stores of brown fat, it would burn off at least 4 kilos of white fat a year. It may be possible to activate brown fat by a drug targeted at particular parts of brown fat's metabolic pathways, which, in future, may provide a viable treatment for obesity

Letters to the Editor

Good teaching material

I am working as a lecturer in the Department of Biological Science, Nehru College of Education and am a member of Pondicherry Science Forum. I have been regularly reading your monthly magazine *DREAM 2047* for past one year. It's very useful for science communication activities and contains good teaching material for graduate students. Hence please send the magazine to me regularly.

M. Sudurshan,
Lecture in Biological Science, Nehru college of Education, Sedarapet, Puducherry-605111

Presents concrete scientific information

Your magazine has given me a lot of information and it helps me expand my knowledge. It presents concrete scientific information in simple terms. It is one of the best magazines being published in India. I read this magazine for the first time in a library a few months ago, but I am not able to get any more issues to read. So, I make a humble request to you to please send this magazine to my house.

Ashok Kumar Pandey
MIG 20 Shree Parisar Colony, Sanjivani Nagar, Jabalpur-482003
E-mail : ayush.pandey.9@gmail.com)

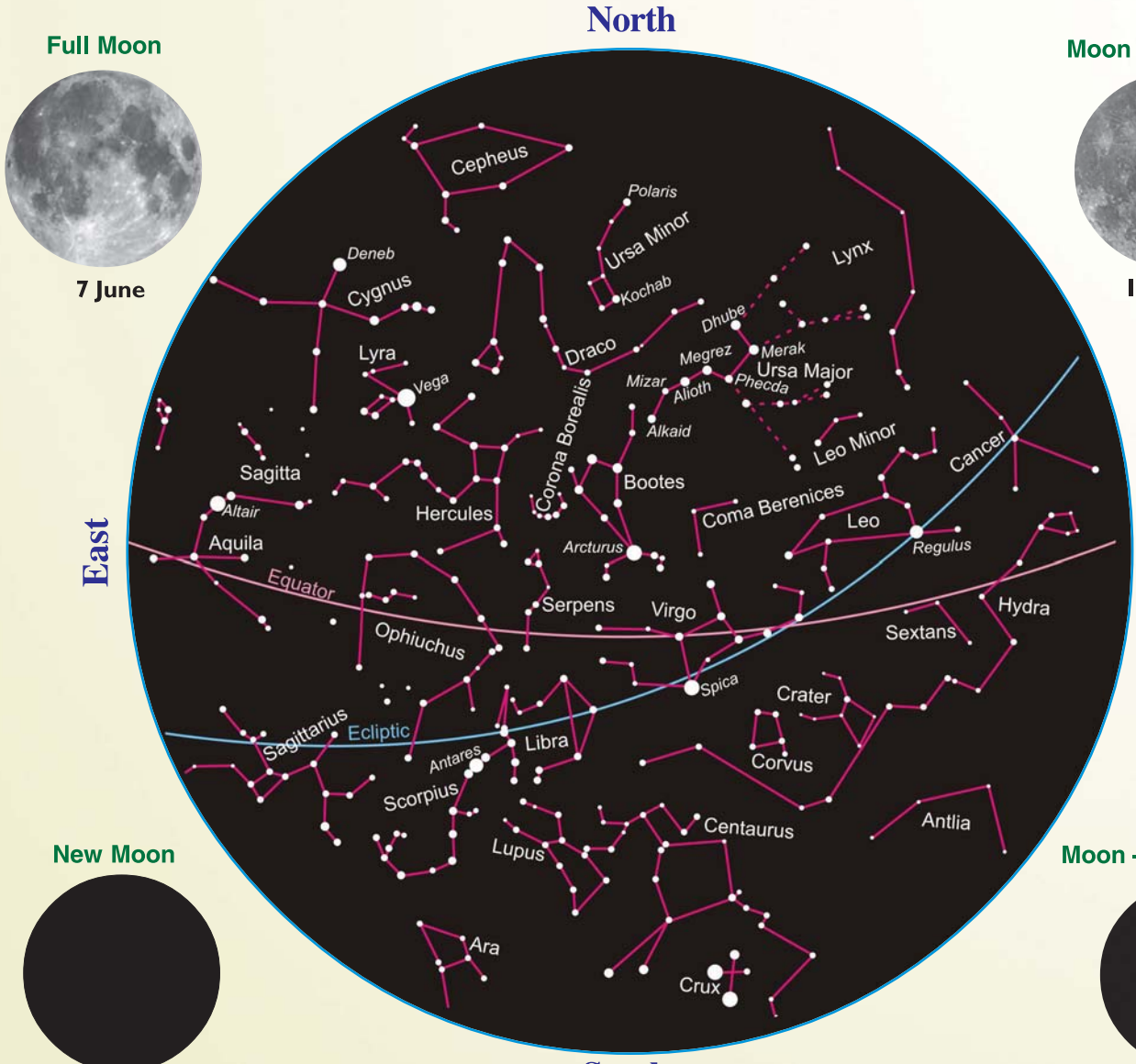
Innovative means to spread scientific knowledge

It is my pleasure to share something about your newsletter *DREAM 2047*. Really it is an innovative means to spread scientific knowledge among the people of society. First time I got to read this newsletter was at the Central Library, K. U., Nainital and I was happy to read the material I found inside. I am engaged in research in botany and would like to share something through this newsletter. So please inform me how I can send articles in Hindi for *DREAM 2047*.

Dinesh Giri
Plant Tissue Culture Lab, Department of Botany, DSB campus K.U. Nainital, Uttarakhand
(E mail: giri_gld@rediffmail.com)

[*DREAM 2047* does not publish research papers. Original popular articles on science topics in English or Hindi may be considered for publication on merit – **Ed.**]

Sky Map for June 2009



Full Moon

7 June

Moon - Last Quarter

16 June

New Moon

23 June

Moon - First Quarter

29 June

The sky map is prepared for viewers in Nagpur (21.090 N, 79.090 E). It includes constellations and bright stars. For viewers south of Nagpur, constellations of the southern sky will appear higher up in the sky , and those of the northern sky will appear nearer the northen horizon. Similarly, for viewer north of Nagpur, constellations of northern sky will appear higher up in the sky, and those of the southern sky will appear nearer the southern horizon. The map can be used at 10 PM on 1 June, at 9 PM on 15 June and at 8 PM on 30 June.

Tips to use sky map:

(1) Choose a place away from city lights/street lights. (2) Hold the sky-map overhead with North in the direction of Polaris. (3) Use a pencil torch for reading the sky map. (4) Try to identify constellation as shown in the map one by one.

Visibility of Planets+ (IST)

	Rising	Setting	In the Zodiac
Mercury	04:08	17:18	Taurus
Venus	02:47	15:29	Pisces -Taurus
Mars	02:48	15:38	Aries
Jupiter	22:54	10:19	Capricorns
Saturn	11:35	00:05	Leo
Uranus*	00:30	12:26	Pisces
Neptune*	22:50	10:16	Capricorns

+Time shown is subject to vary (± 1 hr) from place to place.
*Not naked eye object

Sky Event

Date	IST	Event
06	01:29	Venus at greatest elg. (W)
10	21:34	Moon at apogee
13	17:29	Mercury at greatest elg. (W)
13	23:31	Moon-Jupiter
21	10:10	Venus-Mars
21	11:15	Summer solstice
23	16:09	Moon at perigee

□ **Arvind C. Ranade**
E-mail : rac@vigyanprasar.gov.in

Astronomy

to the glare of the photosphere. The shape of the corona varies with the 11-year solar cycle giving it a different look during every total solar eclipse (depending on whether the number of sunspots is maximum or minimum). And, before you realise what has happened the entire sequence repeats in the reverse order!

Strange things happen in nature in these few moments of totality and few minutes before and after totality! The sunlight is greatly reduced and planets and bright stars become visible to the naked eye. Many plants that close up during night close up during the phase of totality. Plants that give agreeable fragrance during night do so during the totality. Birds get confused. The owls and the bats come out. Fowls sit down where they are, and the cock may crow after totality! Pigeons may go to roost before totality and may come out again after totality is over! Surely, one needs to live through the experience of the total eclipse of the Sun. There is no way it could be explained. It is worth travelling any distance to observe a total solar eclipse.

Why do the scientists eagerly wait for this event? The Sun is the nearest star we can study in minute details, and a total solar eclipse gives us the opportunity to study the atmosphere of the Sun-like stars. Further, the corona can be studied in minute details only during such rare events. Indeed, the element helium was discovered on the surface of the Sun during an expedition on 17 August 1868 in the tobacco fields of Guntur, Andhra Pradesh, by the French astronomer Janssen. This is where the solar physics was born - in the tobacco fields of Guntur! Helium was discovered on Earth only in 1895! It was during the total solar eclipse of 29 May 1919 that the General Theory of Relativity of Einstein was first tested by observing the deflection of light coming from a distant star by the gravitational field of the Sun.

On 22 July 2009, when an exceptionally long total eclipse of the Sun takes place, the path of the Moon's umbral shadow would begin in the Gulf of Khambhat (Cambay), India, and cross through Nepal, Bangladesh, Bhutan, Burma, and China. The umbra of the Moon's shadow will first touch the Earth off the western coast of India at sunrise at 6.23 a.m. at a speed of about 18 kilometres per second. Within seconds, the coastal city of Surat (Gujarat) will experience darkness for 3 minutes and 17 seconds. The Sun would be only 3° above the eastern horizon. The altitude of the Sun, however, would rapidly increase as the umbra rushes eastward. Vadodara in Gujarat will be on the northern limit of totality and will experience darkness for one minute and 19 seconds. The shadow will then reach Indore, which will experience totality for 3 minutes and 13 seconds. The altitude of the Sun here is merely 6° above the horizon. Although Bhopal lies 40 km north of the central line, it would experience totality for 3 minutes and 12 seconds. Varanasi and Patna both lie within the shadow's path. The track of the umbral shadow will then sweep over Darjeeling, Shiliguri, Gangtok, Thimphu (Bhutan), Dibrugarh and Itanagar. It would take only about13 minutes for the umbral shadow to cross India. The shadow then enters northern Myanmar and then China and Japan. After leaving mainland Asia, the path crosses Japan's Ryukyu Islands and curves southeast through the Pacific Ocean where the maximum duration of totality reaches 6 minutes 39 seconds. Here the speed of the umbral shadow would be only about 800 metres per second.

How could one safely watch a solar eclipse? First thing to remember is to never watch the Sun - eclipsed or uneclipsed - with naked eye. It could permanently damage the retina and the vision. For direct viewing of the partial phase of the eclipse, use only tested safe solar filters, or the dark arc welder's glass No. 14. Vigyan Prasar provides safe solar filters in its astronomy activity kits, or even separately for this purpose. Sun's image could be projected onto a wall or a white paper using a small telescope to observe the progress of the eclipse. Safest way of course would be to project the image of the Sun on a shaded wall through a pinhole. The intensity of the uneclipsed portion of the Sun, even when it becomes a thin crescent, remains high enough to cause permanent or partial blindness. Surely, during the phase of totality, one does not require any filters. Preferably, an ex

□ Vinay B. Kamble

Vigyan Prasar and All India Radio

present

54-Episode Astronomy Radio Serial

"Sitaro Se Aage"

Broadcast from First Week of April 2009

in

19 Indian Languages and from 117 stations of All India Radio

Answer the questions at the end of each episode and win attractive prizes

Tune in AIR station in your area

YOUR OPINION

Dream 2047 has been inviting your opinion on a specific topic every month. The reader sending the best comments will receive a popular science book published by VP. Selected comments received will also be published in *Dream 2047*. The comments should be limited to 400 words.

This month's topic:

"Is opening of new Institutes of Technology a viable means of improving the technological capability of the country?"

Response should contain full name; postal address with pincode and email ID, if any; and should be accompanied by a recent passport size photograph. Response may be sent by email (**opinion@vigyanprasar.gov.in**) or by post to the address given below. If sent by post, "**Response: *Dream 2047* June 2009**" should be clearly written on the envolope.

Vigyan Prasar
A-50, Institutional Area, Sector-62, NOIDA 201 307
Phone: 91-120-240 4430/35 Fax: 91-120-240 4437
Email: info@vigyanprasar.gov.in Website: www.vigyanprasar.gov.in

Winners of "Your Opinion" contest for February 2009.

Topic: "As individuals, are we doing enough to lessen the effects of Global Warming?"

Jyoti Bhatia
Pradeep Kumar Society,
Flat No. 8, 2nd floor,
Gabriel Street, Mahim,
Mumbai-400016, Maharashtra

"Each of us can take the following actions to help reduce global warming:

1. Reduce, reuse, and recycle as far as possible. Prefer reusables over disposables.
2. Use less heating in winter and air-conditioning in summer.
3. Replace tungsten light bulbs with compact fluorescent lamps; they consume 75% less electricity and give off 70% less heat.
4. Drive less to reduce emissions and practise carpooling.
5. Turn off lights when not in rooms or when not using computer, TV, home appliances, etc."

Syed Sajaad Yousuf Shah
S/o Syed Mohd. Yousuf Shah,
Distt.: Puwama, Kashmir,
J&K-192123

"We should follow the famous dictum 'think globally and act locally' to improve our environment. In order to lessen the global warming we need to control deforestation and promote afforestation. The *chipko* movement led by a Bishnoi woman Amrita Devi in Rajasthan 300 years ago, and recently in 1987, the afforestation programme led by former army regular Soban Singh Bhandari in Tehri in Uttaranchal highlight the individual efforts to lessen the efforts of global warming."

The winners will receive a copy of VP Publication