



Vigyan Prasar

DREAM 2047

November 2009

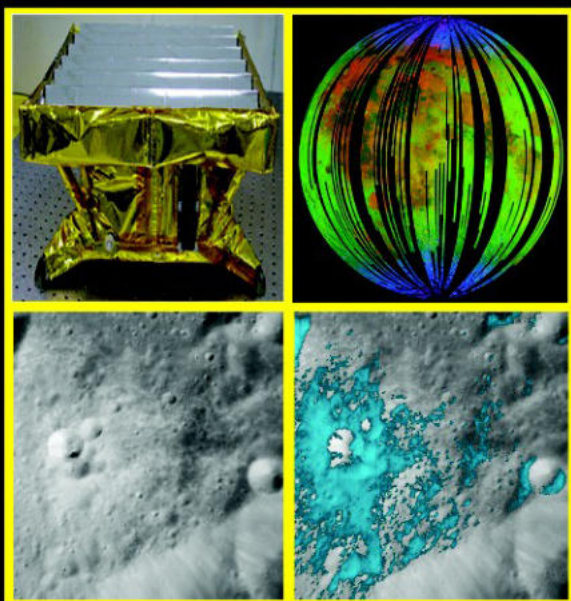
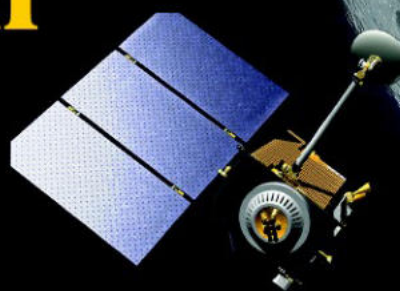
Vol. 12

No. 2

Rs. 5.00

Nobel Prizes
2009

Water on Moon



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Little Water Big Excitement

The first ever scientific observation of the Moon was made by Galileo 400 years ago when he used his new invention - the telescope - to observe mountains and craters on the lunar surface. The era of space exploration began in 1960s. That is when observations of the Moon received a boost with fly-by, orbiting, landing of space probes, and finally the manned missions and analysis of its rocks for over four decades. Indeed, our fascination with the Moon continues to grow with time. The Moon has now parted with one of its most tantalising secrets giving a boost to the quest for our understanding of the cosmos. India's *Chandrayaan-1* Moon Mission, before dying an early death in August 2009, confirmed that the Moon is not dry after all. There *is* water on the Moon. Moon Mineralogy Mapper (M3), the NASA payload, on board *Chandrayaan-1* spacecraft (launched on 22 October 2008) detected unmistakable signs of water molecules at many places on the surface of our celestial neighbour.

Much before humans had set foot on the Moon, scientists believed that there might be water on the Moon. However, when samples of lunar rock and soil brought back by the Apollo astronauts were analysed, the results were not encouraging. The Moon appeared to be "an exceedingly dry place." However, the possibility of water-ice in the polar regions of the Moon could not be ruled out, since they are permanently shadowed from sunlight. Due to the very slight tilt (only 1.5°) of the Moon's axis, some of the deep craters, particularly near the polar regions never receive any light from the Sun - they are permanently in shadow and can act as permanent trap of water molecules. In

such craters scientists expected to find water in frozen form. It was this hope that revived the search for water on the Moon in the 1990s.

Most of the earlier explorations till mid-1990s appeared to confirm that the Moon was a dry rocky body. As a result of its low gravity (only one-sixth that of the Earth) the Moon has no atmosphere. Any water would have long been lost in space. Or so it was thought. This consensus of a barren, waterless Moon came under increasing doubt, starting with the 1994 *Clementine* mission. In the quest for detecting ice on the Moon, the radio transmitter on board *Clementine* spacecraft (launched in 1994) was used to bounce radio waves off the surface of the Moon to a station listening back on Earth. The energy of the reflected radio waves, incidentally, is a function of the compositional properties of the surface from which they are reflected. Rocky surfaces scatter radio waves randomly, while icy surfaces reflect radio waves coherently. By distinguishing between weak radar return signals and strong radar return signals, it is possible to detect deposits of ice. Radar waves were bounced off of the Moon's north and south poles as well as areas around the poles. The non-dark region displayed the characteristic radar return from a rocky silicate surface. However, the permanently dark regions at the South Pole had the radar reflectance properties of water ice. Radar data collected from the lunar North Pole and other regions without permanent darkness did not have the ice signature.

The *Lunar Prospector* (launched in 1998) was designed for a low polar orbit investigation of the Moon, including mapping of surface composition and possible polar water ice deposits. The

technique used for finding the evidence of water was neutron spectroscopy in which a neutron spectrometer on board the spacecraft determines the number of neutrons that interact with wet lunar soil as compared to the dry lunar soil. Neutrons, incidentally, are the neutral constituent particles of the nuclei of elements along with positively charged protons. Lunar soil containing water significantly slows down the fast moving neutrons due to collisions with the hydrogen ions in the water molecules. This technique thus gives the definitive signature of the presence of water. On 31 July 1999 the *Lunar Prospector* impacted the Moon into a crater near the South Pole in a controlled crash to look for evidence of water ice. No conclusive evidence of water ice, however, was found. We may note that water molecules and hydroxyl (OH) radicals were suspected in data from *Cassini* spacecraft flyby of the Moon in 1999, but the findings were not published until now.

In 2008, Japanese researchers declared that careful analysis of images taken by the *Kaguya* (*Selene*) spacecraft did not throw up any sign of water ice inside a key crater at the South Pole. In the same year, U.S. scientists published a study that used new techniques to examine beads of volcanic glass collected by two Apollo Missions. They found minute traces of water! It suggested that water had perhaps been a part of the Moon since its formation and could be found deep inside it. Against this background, the discovery of traces of water by the *Chandrayaan-1* is of huge scientific interest. *Chandrayaan's* observations are also supported by findings from two U.S. deep space missions that gazed at the Moon as

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

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Published and Printed by Dr. Subodh Mahanti on behalf of Vigyan Prasas, 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**

Claudius Ptolemy

The Last Great Classical Astronomer

□ Subodh Mahanti

E-mail: smahanti@vigyanprasar.gov.in

“Ptolemy was the last of the great classical astronomers, and his work dominated astronomical thought for almost 1500 years. The collapse of the Ptolemaic model and the rise of a new model of the universe make an exciting story, but it is not just the story of an astronomical idea. It includes the invention of science as a new way of knowing and understanding what we are and where we are.”

Michael A. Seeds in *Foundations of Astronomy* (Seventh Edition), 2003

“He (Ptolemy) produced four major works the *Almagest*, the *Geography*, the *Tetrabiblos* and the *Optics*. The first work (the *Almagest*)—the culmination of five hundred years of Greek astronomical and cosmological thinking—was to dominate science for 13 centuries. Ptolemy naturally relied on his predecessors, especially Hipparchus. A work of such staggering intellectual power and complexity could never be created by one person alone.”

A Dictionary of Scientists, Oxford University Press, 1999

“His (Ptolemy’s) work was far more than compilation of former knowledge. Ptolemy was no compiler but a scientific investigator himself; with Hipparchus he was the greatest astronomer of antiquity. He improved and extended the theories of his predecessors; he added to science through his own observations and explanations.”

A. Pannekoek in *A History of Astronomy*, Dover Publications, Inc., 1961

There is virtually no information about Ptolemy’s personal life. The belief that he was of Greek origin is derived from his name. His first name “Claudius” indicates that he was a citizen of the Roman Empire. His Latin name is Claudius Ptolemaeus and Arabic scholars referred to him as Batlamyus. His last name “Ptolemy” indicates that he descended from a Greek family living in Egypt (some believe that ethnically he was an Egyptian, though Hellenised). There is no proof to indicate that Ptolemy was related to the royal dynasty of the Ptolemies. In fact many scholars and historians consider it very unlikely. We do not know the exact dates of his birth and death. It is believed that he was born around AD 90 and died in AD 168. It is assumed that his teacher was Theon of Smyrna, who was a well-known Greek mathematician and astronomer of his time. Ptolemy probably made astronomical observations during the years AD 127 to 141 in Alexandria. He wrote in ancient Greek and made use of Babylonian astronomical data. It is assumed that he wrote many



Claudius Ptolemy

scientific treatises but that not all have survived.

The ideas of Plato and Aristotle, the two great Greek philosophers, on the nature of the universe dominated the human mind for more than 2000 years. Ptolemy played a

crucial role in ensuring the survival of the Aristotle’s universe by fitting to it to a sophisticated mathematical model. Aristotle had proposed that the heavens were literally composed of 55 concentric, crystalline spheres to which celestial objects were attached.

The Earth is at the centre of the universe. The known planets, as well as the Moon and Sun, in order of increasing distance from the Earth—the Moon, Venus, Mercury, Sun, Mars, Jupiter and Saturn—travelled around the Earth. In this model the spheres rotate at different velocities but the angular velocity of a given sphere remains constant. Additional “buffering” spheres lie between the spheres shown in the diagram. Aristotle thought that there was an outermost sphere, the domain of the “Prime Mover”. According to Aristotle it was the “Prime Mover”, that caused the outermost sphere to rotate at constant angular velocity and which was transmitted from sphere to sphere to rotate the entire system.

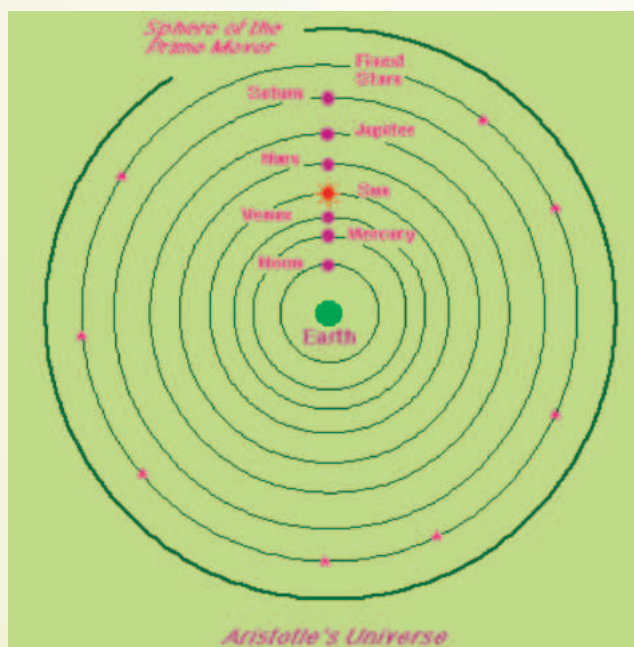
By adjusting the velocities of the concentric spheres, the Aristotelian model of the universe was able to explain many features of planetary motion. However, it failed to explain many observable phenomena, for example varying planetary brightness and retrograde motion. Ptolemy introduced the concept of epicycles to improve the Aristotelian model. He argued that the planets were not directly attached to the concentric spheres. Rather they were attached to the circles attached to the concentric spheres as shown in the diagram below:

The circles attached to the concentric spheres were called 'epicycles' and the concentric spheres to which the planets were attached were called 'deferents'. In this model, the centres of epicycles moved in uniform motion as they moved around the deferents at constant angular velocity and at the same time the epicycles to which the planets were attached maintained their circular motion.

With this kind of a model, Ptolemy was able to account for the retrograde motion and the varying brightness of the planets. It is obvious that the distance of a planet from the Earth would vary, which in turn would lead to variations in brightness. Further, at times viewed from the Earth, a planet can appear to move "backward" on the celestial sphere and thus, Ptolemy's model effectively explained the retrograde motion. Ptolemy not only improved the Aristotelian model but also tried to preserve intact the concept of the geocentric universe.

Ptolemy presented his astronomical and mathematical ideas in his greatest work, the *Almagest*. For over 1400 years *Almagest* was not only considered as the most important treatise on astronomy but the very subject was defined as what was described in it. It was indeed the last word in astronomy for centuries! Undoubtedly it is one of the scientific texts that remained in use for an extraordinary length of time. In this respect it can be compared with Euclid's *Elements*. The original name of the Ptolemy's work that we know as the *Almagest* was *The Mathematical Compilation* (the English

version of the Greek title). Later the title was replaced by another title, which in English meant *The Greatest Compilation*. The last title was translated into Arabic as "*al-majisti*" ("The Greatest") and from which the title the *Almagest* is derived. It may be noted that like many other Greek texts, the Arabic manuscript of Ptolemy's work on astronomy also survives. Hence the name "the *Almagest*" derived from the Arabic title is more familiar. The book was translated from Arabic into Latin in the 12th century and gained familiarity under the title *Almagest*. It was translated twice into Latin.



Aristotle's Universe

There are additional buffering spheres that lie between the spheres shown here (Source : csep10.phys.utk.edu/ast161/lect/retrograde/aristotle.html)

Highlighting the importance of the *Almagest*, English historian and author G.J. Toomer wrote: "As a didactic work the *Almagest* is a masterpiece of clarity and method, superior to any ancient scientific textbook and with peers from any period. But it is much more than that. Far from being mere 'systemisation' of earlier Greek astronomy, as it is sometimes described, it is in many respects an original work."

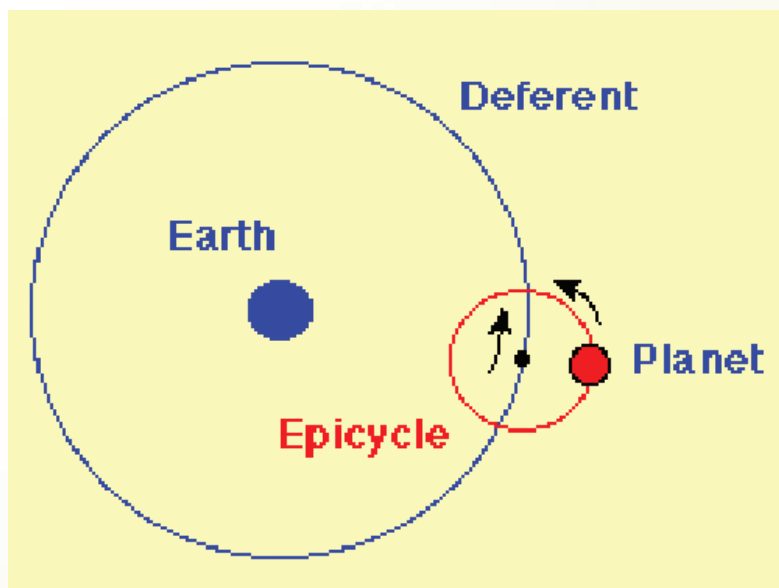
The system described in the *Almagest* is known as Ptolemaic system. It was a geocentric model of the universe and was based on circular uniform motion. In the *Almagest*, Ptolemy presented the details of the mathematical theory of the motions of the

Sun, the Moon and the planets. Ptolemy's most original contributions were the details for the motions of each planet, which he worked out. Commenting on the approach followed while writing the book, Ptolemy wrote: "We shall try to note down everything which we think we have discovered up to the present time; we shall do this as concisely as possible and in a manner which can be followed by those who have already made some progress in the field. For the sake of completeness in our treatment we shall set out everything useful for the theory of the heavens in the proper order, but to avoid undue length we shall merely recount what has been adequately established by the ancients. However, those topics which have not been dealt with by our predecessors at all, or not as usefully as they might have been, will be discussed at length to the best of our ability."

The *Almagest* is divided into 13 books. The first two Books of the *Almagest* describe new geometrical proofs and theorems devised by Ptolemy. The theory of the Sun forms the subject of Book 3. In Books 4 and 5 Ptolemy presents his theory of the Moon. In Book 6 Ptolemy describes his theory of eclipses. Books 7 and 8 contain Ptolemy's star catalogue that describes over 1,000 stars. The last five Books (9 to 13) discuss planetary theory. The *Almagest* was finally superseded by the celebrated works of Copernicus

and Galileo.

Ptolemy published a major work on geography called *Geographia* or *Geography* (the full Latin title is *Geographia Claudii Ptolemaei*). It was a compilation of what was known about the world's geography in the Roman Empire during his time and is spread over eight volumes. The original work included maps but because of the difficulty in copying them, these maps were left out while making subsequent copies. The first Latin translation was made by Florentine Giacomo da Scarperia in 1406 and subsequently it was translated in many other languages of the world. The first printed edition of the book was brought out probably



Epicycle and deferent in the Ptolemaic System
(Source : csep10.phys.utk.edu/astr161/lect/retrograde/aristotle.html)

in 1477 in Bologna. This was the first printed book with engraved illustrations. To some extent Ptolemy relied on the work by Marinus of Tyre; an earlier geographer. He also depended on the gazetteers of the Roman and ancient Persian Empire.

Ptolemy also provided instructions on map-making. Though maps based on scientific principles, were made by Eratosthenes as early as the 3rd century BC; Ptolemy improved projections. *Geographia*

because the quality of the available data was very poor.

Ptolemy's third most important work was on astrology. In Greek it was called *Apotelesmatika* ("Astrological Outcomes or Effects") and in Latin, *Tetrabiblos*. In Latin "*tetra*" means four and "*biblos*" means book. So *Tetrabiblos* literally means Four Books. The book became popular throughout the world. Even today it is considered as the ultimate source on astrology. It is very likely



Ptolemy's World Map

attempted to map the known world giving coordinates of the major places in terms of latitude and longitude. Ptolemy created a series of 26 maps and also a general map of the world. However, Ptolemy's maps were often inaccurate but this is not surprising

that the contents of the book were collected from earlier sources. What Ptolemy did was to arrange the material in a systematic way.

Ptolemy also wrote a book on optics in five volumes, where he discussed his studies on colour, reflection, refraction, and mirrors

of various types. He carried out many experiments on optics and came to the conclusion that starlight was refracted by the Earth's atmosphere.

Ptolemy also wrote an influential work, *Harmonics*, on musical theory and the mathematics of music. In *Harmonics*, Ptolemy described how musical notes could be translated into mathematical equation and *vice versa*. Like Pythagoras, he too argued for basing musical intervals on mathematical ratios. However, Pythagoras's approach was theoretical but Ptolemy based his arguments on empirical observations.

The crater Ptolemaeus on the Moon, the crater Ptolemaeus on Mars, and the asteroid 4001 Ptolemaeus have all been named in honour of Ptolemy.

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(The article is a popular presentation of the important points on the life and work of Claudius Ptolemy available in the existing literature. The idea is to inspire the younger generation of know more about Claudius Ptolemy. The author has given the sources consulted for writing this article. However, the sources on the Internet are numerous and so they have not been individually listed. The author is grateful to all those authors whose works have contributed to writing this article).

Radium Girls and Their Legacy*

□ Vinay B. Kamble

Email: vbkamble@vigyanprasar.gov.in

There is a century-old true story that revolves around five girls famous in history as the “Radium Girls”. Within two decades of its discovery by Marie and Pierre Curie in 1898, radium found applications in different industries besides medicines. From 1917 to 1926, the US Radium Corporation produced radium based products – including luminous paints at their plant underneath the sleepy suburbs of Orange, New Jersey, USA. The plant produced radio-luminescent watch faces and employed nearly 100 workers – mainly women – to paint the radium paste on watch faces and instruments. The workers mixed

over the counter until 1931. Residues from US Radium Refineries were used to make sand for children’s sand boxes. In 1922, however, a dial painter girl began to complain of toothache. She was suffering from necrosis (death of living cells) of the jaw. The other women suffered from anaemia and bone fractures. Almost all girls had unusual blood conditions. Some had tumours bulging from their jaws and leg bones, where radium had settled. Meanwhile, the owners and scientists of US Radium – familiar with the effects of radium – carefully avoided any exposure to themselves using lead screens, masks and tongs around the material. Like other factory workers at that time in USA – and in India even today – the workers were expendable.

Grace Fryer and four other girls – who came to be called the Radium Girls – decided to sue US Radium in 1925. Her teeth had started falling out and her jaw developed a painful abscess. X-ray photos of her mouth and back showed the development of serious bone decay. Grace and her fellow workers had some success in their battle against US Radium. The company paid them a combined settlement of about US\$ 20,000. But it never admitted its own responsibility towards workers. (Remember, even Union Carbide never accepted its responsibility towards its workers and over 20,000 dead, after the Bhopal Gas Tragedy in 1984!) All this, however, was too late for Grace and her colleagues. All five women were dead by 1930s. But, as a result of their case, the right of individual workers to sue for damages over labour abuse was established; labour safety standards were created; and industrial safety standards were comprehensively improved. The story of the Radium

Girls eventually led to a complete revision of how radioactive materials were viewed, handled and used. The story outlines the different aspects of the occupational hazards and concerns for safety - in particular ignorance on the part of the workers and the apathy of the management.

A Drain Choked

Let us now consider the plight of the poor labourers working in unhygienic and sometimes life-threatening environment without any protection. A few years ago, a few workers came to clear a blocked drain near my house in Delhi. One of them stripped to his bare minimum and entered the drain after opening the cover of the manhole - without any mask to protect him against odious fumes, no protective gloves and just a primitive spade as a tool to clean the drain. It took



Standard symbol for radioactive material

glue; water and radium powder together and applied the glowing paints onto the racks of dials with camel hair brushes. The brushes lost their shape after a few strokes, so the women pointed them with their lips to keep them sharp. The women often painted their nails, teeth and their faces with the radium paint for entertainment when the lights went out. By the time they left their work, their skin and hair would glow!

Obviously, the lack of concern over radiation was endemic at the time. Radium was the new wonder substance considered to be a miracle drug that cured anything from arthritis to cancer. Even a radium medical drink was sold



Without appropriate gear, municipal sanitary workers in India are exposed to avoidable health risks

nearly one hour for him to clean the drain. After his job was over, he took bath with a bucket of water given to him and complained, “Nobody cares about our safety. If we don’t clean the drains, the city would come to a standstill and still nobody looks into our needs. We contract diseases by working in fatal conditions, and yet authorities do nothing for us.”

Well, this is a common sight ahead of the monsoon when sewage and drain cleaners are called and employed by Municipal Corporation of Delhi (MCD), Delhi Jal Board (DJB), and New Delhi Municipal Corporation (NDMC); and made to work under similar conditions. These workers need to be equipped with masks, gumboots and oxygen tanks in case the drain is deeper than 1.5 metres. Since there is not enough oxygen in drains, it often results in hypoxia (that is, lack of oxygen). These workers are also susceptible to skin and fungal infections. They ideally need to undergo medical check-ups every six months as they are susceptible to gastrointestinal disorders, stomach infection, cholera, typhoid and respiratory disorders arising due to inhalation of methane and other harmful gases. Between 3 August 2008 and 13 May 2009, as many as 21 workers died in the mire while cleaning the drains of these, three were DJB employees while the rest were daily wage earners working on contract. The municipal authorities have minimal or no responsibility towards the daily wagers, anyway!

Salt Workers in Desert Areas of Gujarat and Rajasthan

How is salt obtained? The subsoil brine in the desert areas of the Little Rann of Kutch in Gujarat and Western Rajasthan contains very high salinity (15-20%) as compared to that of seawater (3.4%). The workers engaged in the salt production under the unorganised sector have to stay and work in isolation at the remote sites in the adverse weather of the desert during the work season, which is from October to June. The workers, most of the time barefoot, enter the brine for 6-8 hours during the process of crystal reshuffling. The hazardous effects of



Working barefoot, salt workers in the Rann of Kutch suffer from a host of skin and other ailments

intense reflection of sunlight from the salt and a direct effect of sodium chloride dust on mucosa (that is, mucous secreting membrane) of the eye are responsible for various eye morbidities, whereas the direct contact of feet and hands with highly concentrated salt solution causes different types of skin problems. In addition, they also suffer from hypertension.

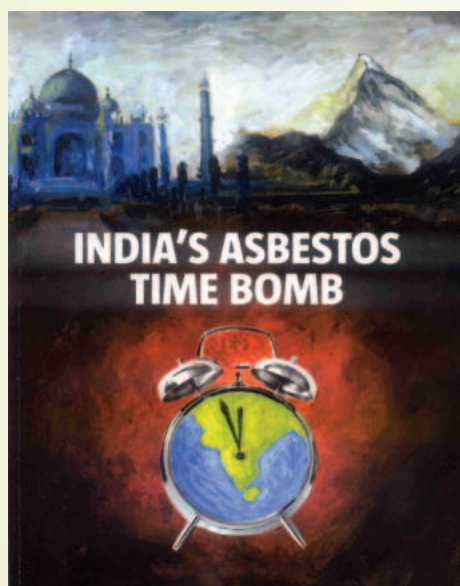
The National Institute of Occupational Health (NIOH), Ahmedabad, carried out a study on 143 workers (103 men and 40 women) from a salt manufacturing site in the Little Rann of Kutch and a control group of 128 subjects (76 men and 52 women) from a nearby village. Skin abnormalities were observed in 51.74% salt workers as compared to 11.71% controls, whereas the eye abnormalities were noted in 45.45% of workers and 33.59% of control subjects. In addition to this, high prevalence of hypertension was observed in both – the control and exposed groups. The controls had a prevalence of 13.15% in men and 19.23% in women, whereas in the salt workers it was still higher – 40.77% and 30.0% for respective sexes. The exposed group also showed an overall high prevalence (22.3% in men and 17.5% in women) of hypertensive

retinopathy – a disease of the retina which results in impairment or loss of vision – as compared to controls.

Asbestosis

Now let us talk about a material that we use day in and day out. It is used for reinforcing cement and plastics, fireproofing, sound absorption as well as in umpteen insulating applications in electrical and mechanical gadgets. Asbestos cement sheets and pipes are used for construction. Ship-builders utilise asbestos to insulate boilers, steam pipes and hot water pipes. The automobile industry uses it in vehicle brake shoes and clutch pads. Yes, we are talking about asbestos which means “indestructible” in Greek. Its tensile strength and resilient structural and chemical properties of asbestos fibres make it ideally suited for these applications. Over 5,000 products we use contain asbestos!

Incidentally, asbestos is the generic term for a number of fibrous silicate minerals. There are two major groups of asbestos – the ‘amphibole’ group, which includes blue (crocidolite) and brown (amosite) asbestos, and the ‘serpentine’ group, which includes white asbestos (chrysotile). Blue and brown asbestos is banned in all the countries. White



A publication brought out by the International Ban Asbestos Secretariat, UK, warns of the potential risk of widespread asbestos use in India

asbestos also is banned in most developed countries, but is rampantly used in Asian and African countries. The structure of asbestos is fibrous; and it is a proven fact that exposure to asbestos fibres can cause 'asbestosis' – lung diseases caused by inhaling asbestos particles, lung cancer, and mesothelioma or cancer of the thin membrane enclosing the lungs. At the workplace, mechanics and brake workers can be exposed to asbestos dust in different ways, including during cutting, scraping, grinding brake shoes and refurbishing brakes or clutches. The toxic effects of asbestos depend upon the cumulative dose and the time since the first exposure. Asbestos related diseases occur after 15 to 40 years of latency period following exposure. Canada exports 95 per cent of the asbestos it produces to Asian and African countries, fully knowing its harmful effects on health! India consumes some 3 lakh tonnes of asbestos every year, most of which is imported, and of which a chunk is from Canada! However, all forms of asbestos cause cancer and are known human carcinogens.

We may note that asbestos in cement pipes or sheeting is not a risk to the general public as the fibres are in a matrix and cannot easily break into smaller particles. However, over time,

asbestos cement breaks down over time and fibres become free, and thus can pose a risk to the general public. A fact sheet on asbestos brought out by a New Delhi based NGO states that asbestos mining and milling activity is concentrated in the small-scale sector in India, while the products are manufactured by the small, medium and large scale sectors.

Indeed, these tiny factories do not exist in government records. Nor do they figure in the lists of pollution control boards or other regulatory bodies. Even as they have mushroomed in small towns, they are also sprouting in the dark by-lanes of congested localities in large cities. They function from one or two-roomed quarters and employ five to 10 labourers. Covered from head to toe in toxic dust, these unwary workers go about their job oblivious of the fact that they are breathing death in lungfulls. This is the ugly face of the unorganised small-scale asbestos manufacturing industry. Occupational exposure to asbestos occurs during mining operations too. Till a few years back, asbestos was mined in Andhra Pradesh, Bihar and Rajasthan. But after the ban on extension of leases, mining activity in Andhra came to a halt. In Rajasthan, however, illegal mining continues unabated. Despite being a versatile material and its many uses, it poses real occupational hazards.

A Nurse in a Hospital

Victor Hugo, in his famous novel *Les Misérables*, has said that a school teacher and a nurse are the greatest functionaries of the society. But what it takes to be the greatest functionary like a nurse? I have a colleague whose wife is a nurse in a Government hospital in Delhi. And her occupation as a health worker itself poses many hazards to her own health! A hospital

is open all day long and she may have morning, afternoon or night shift. Often there are patients with psychological problems.

Nurses are more likely to contract disease. More so, when there is an epidemic like the Swine Flu that spreads through close contact with the patients and also through the air! However, under normal circumstances, Hepatitis B and Hepatitis C are quite common in health care workers, though most health care workers are vaccinated against Hepatitis B. HIV is a problem too, particularly with needle sticks. Accidentally pushing a needle into oneself is quite possible. Tuberculosis and other airborne diseases are also an issue. Nurses have to be checked regularly for tuberculosis.

Due to the constant use of antibiotics in hospitals, bacteria resistant to common antibiotics are



A Nurse in a Hospital

commonplace in hospitals. Nurses are more likely to contract such infections, and such infections are much harder to cure than standard bacterial infections. Further, exposure to cuts, blood and body fluids is a real hazard. That is why the nurses are required to wear gloves, which are generally made of latex. But, this could cause latex allergies. Nurses are required to wash their hands a lot which could dry out their hands. The hours of duty for nurses are sometimes quite demanding. Hospitals are open 24 hours and the shifts could be as long as 12 hour long. As a result, they often

suffer from stress and sleeping disorders. Seeing the people die and long hours away from home could give rise to psychological and emotional problems too. Since they have relatively easy access to drugs, there is also a likelihood of abusing the drugs.

Time, Distance, Appropriate Shield

The hazards we described in diverse occupations above point to three basic tenets of occupation safety. To illustrate these, let us once again go back to the story of the Radium Girls, and extrapolate it to nuclear reactors or nuclear medicine where one needs to handle a variety of radioactive sources. It is intuitive to realize that the more *time* spent around a radioactive source, the more exposure or dose an individual will receive. It is important to consider the *rate* at which the dose is received and for what duration. Complacency in the work place could lead to increased exposure of harmful radiation overtime.

The second aspect of radiation safety is the *distance* from a radioactive source. The greater the distance, the less is the radiation received. This concept can be likened to a fire place giving off heat. As an individual moves away from a fire place, the warmth from it decreases as the inverse of the square of the distance. If you move twice the distance from the source of heat, you would receive only one fourth of the radiation. Hence, it is prudent to occasionally conduct a direct survey of the work area with a radiation meter whether distance can be increased to reduce radiation exposure.

The third aspect is the proper *shielding* from harmful radiation. While dealing with radioactive sources, it is important to use appropriate shielding made of specific materials and thickness depending on the ionizing radiation the radioactive source emits. We come across a variety of radiations, say alpha, beta, gamma, or positron radiation or X-rays. There even could be a combination of these radiations. What

is more, pregnant women are especially vulnerable. The possible side-effects of radiation from radioactive sources could include growth retardation of the foetus, mental retardation and even malformations – other than cancer. Do we see similarities between occupations employing nuclear technology, and other occupations / industries like fertilisers, pesticides, power generation plants, pharmaceuticals, and so on?

The Legacy of the Radium Girls

We took a few examples from diverse spheres of human activity – the radium girls working with radioactive sources, drain workers from Delhi, salt workers from Gujarat and Rajasthan, asbestos workers working especially in the unorganised sector, and nurses in a hospital. In nuclear technology where workers are exposed to lethal radiation, we saw that the basic three tenets of radiation safety include the time and rate of exposure, distance from the radioactive source and effective shielding for protection from such radiation. How do we apply these tenets in a coal mine? Time of exposure from dust in a coal mine, the rate at which a worker is exposed to the dust, how near or far he or she is from the source of the dust, and how effective shielding from the dust are some parameters that would constitute the occupational safety in a coal mine. We can similarly develop safety standard for other occupations as well.

Before I conclude, let me make a couple of comments. The Bhopal Gas Tragedy has parallels with the case of the Radium Girls - and that too on a much larger scale. It also has parallels with the Three Mile Island disaster and the Chernobyl disaster, and tragedies in our coal mines. The tragedy lives on. How do we ensure occupational safety in diverse occupations, then? What needs to be ensured is the development of standards for each occupation and strict observance of the safety norms while establishing a potentially

hazardous industry. We also need to conduct on-going studies on the environmental impact of an industry, and preparedness of people living in the immediate neighbourhood to face up to a possible disaster should it ever take place. These measures would go a long way in avoiding tragedies like the Bhopal Gas Tragedy. Further, it is imperative that the hazardous industrial plants which are already working in different parts of the country be tested periodically for safety. Workers in the industry and people living in the neighbourhood need to be made aware of the plant, its products and the potential threat it poses. It is also advisable to conduct mock-drills and be prepared in case a disaster does take place. This is the true legacy of the Radium Girls.

Finally

Let me emphasise that every job has its own hazards. My job often takes me to different places in the country. Here is one hazard that never crossed my mind earlier. On my flight to Guwahati a few days ago, I got a seat next to the emergency exit. The air hostess explained in the sweetest voice that in order to open the exit I shall have to pull the handle down. But first I must look out of the window and assess the conditions outside. "If you see smoke or fire outside, you should not open the exit", she said. A passenger sitting next to me asked, "But is it not dangerous to open the exit while the plane is flying?" To which she replied, "Not to worry Sir, it won't open in mid-air, no matter how hard you try!" My neighbour blurted out, "You mean it opens only after we have already crashed?" The air hostess politely said, "We do not think like that! It can be used only if there is an emergency!" My neighbour almost fainted, "What's the point? I'll already be dead then!"

**Adapted from a talk delivered at the Regional Labour Institute, Faridabad, Haryana, on 01 September 2009*

Can We Cope?

The Stress Syndrome



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

The reasonable man adapts himself to the world; the unreasonable one persists in trying to adapt the world to himself.

—George Bernard Shaw, *Man and Superman*

Like it or not, stress—the modern day sabre-toothed tiger—is on the loose. Ready to snarl and gnaw at you and make mincemeat of you, if you let it. You must not fight it, nor flee from the scene, but keep it on a leash without letting it get perilously close. This may not be easy. Its progeny romps everywhere, be it the streets of your city, your office, or home, in so many shapes and forms that you may sometimes even fail to recognise their real face till they are at your neck.

Stress pundits believe that *Homo sapiens* were never under so much pressure before. At the dawn of human history, man did have the demands of protection from natural elements—rain, Sun, darkness at night, extremes of temperature, storms, and hurricanes, he had to hunt for food and shelter, was himself hunted, but the dangers were recognisable, not lurking in the dark.

The modern jungle is far more menacing and treacherous. Panic over a deadline, fiercely competitive workplace, an insecure boss, people not keeping time and sending the entire day's schedule into a topspin, overcrowded housing facilities, long queues, jam-packed roads, honks and hackles, a reckless driver on one's tail are the new beasts over which you have no control. They can make your muscles tense, set your heart and lungs racing, put the teeth on edge, wash you up with your sweat, and you cannot even pick a rock and hurl at them. The physiological elements that prepared our ancestors for the fight-or-flee response serve no useful purpose in these settings. The burst of adrenaline is inappropriate to today's social stresses. It is in fact dangerous and

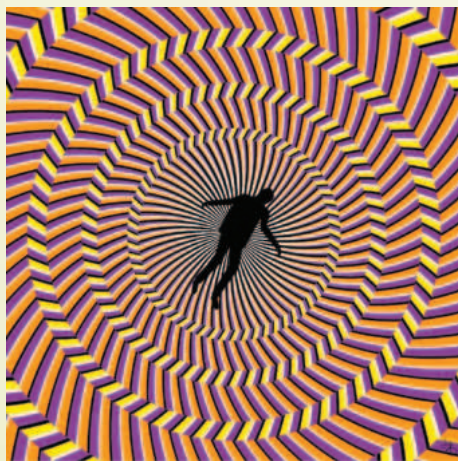
takes a heavy toll on your physical and psychological well-being.

What is stress?

Before we take a reality test on different elements of modern day stress, let us try



and understand what stress actually means. Broadly, it is an unpleasant state of emotional and physiological arousal that we experience in situations that we perceive as dangerous or threatening to our well-being; yet, if you ask people what stress means to them each may come



up with a different answer. Some people describe stress as events that cause them to feel tension, pressure, or negative emotions such as anxiety and anger. Others view stress as the response to

adverse situation. However, most psychologists regard stress as a process involving a person's interpretation and response to a threatening situation.

To be honest, none of the descriptions are wide of the mark. Yet the simplest definition is the one enunciated by the founding father of stress research, Dr. Hans Selye. Born in Austria, Selye was a medical student at the University of Prague when he got interested in what he described as a pre-disease 'stress syndrome' and devoted more than 50 years of his life to work out and identify its secrets. According to Dr. Selye, stress is simply 'the rate of wear and tear in the body'.

The wear and tear occurs when the flight-or-fight response gets too pervasive, becomes chronic, and allows no let-ups. It is associated with an extraordinary set of physiochemical changes, with ramifications in the brain, the nervous system, and in almost all the major organs of the body.

Sources of stress

The events that cause stress are called stressors. Stressors vary in severity and duration. For example, the responsibility of caring for a child born with birth defects may be a source of continuous major stress, whereas getting late to office may lead to mild, short-term stress. Some events, such as the death of a loved one, are stressful for everyone. Yet in other situations, people may respond differently to the same event—what is a stressor for one person may not be a worry for another. For example, a student who is unprepared for a test and knows he will get a bad grade will be under stress, whereas his classmate who studies in advance may go out confident by of a good grade. An event or situation becomes a stressor for a person when they appraise it as threatening, and lack the coping resources.



Stressors are broadly classified into three categories: major social events, which include natural and man-made catastrophes, major events in an individual's life, and everyday annoyances or hassles of life that all of us must live with.

Major social events

Life may suddenly come under the shadow of a serious, life-threatening calamity or disaster. Earthquakes, fires, floods, tornadoes, hurricanes, wars, terrorist attacks, and big-scale accidents can push people to the limits of endurance. For example, there are reports that survivors of the Bhuj (Gujarat) earthquake continue to suffer nightmares and other several emotional problems years after the event. Similarly, many of the survivors of India-Pakistan partition trauma continued to show serious emotional disturbances long after they were settled.

Major life events

Any new event, even positive events such as the birth of a child, a child leaving home for a better future, your own major personal achievement brings you some stress. The list of negative stressful events may be endless—a death in the family, divorce, imprisonment, losing one's job, a major personal illness. All these occupy the high seats of stress.

Researchers have found that experiencing a large number of major life changes in a short period of time can affect the health more adversely. Two American researchers in particular, psychiatrist Dr. Thomas Holmes and psychologist Dr. Richard Rahe, have explored the linkages, drawing on extensive clinical research. They have come up with a social readjustment rating scale and, also, a predictive risk score. You might want to take a photocopy of the scale given here to calculate your score.

Social Readjustment Rating Scale*

Event	Stress points
Death of spouse	100
Divorce	73
Marital separation	65
Death of a close family member	63
Jail term	63
Personal injury or illness	63
Marriage	50
Fired at work	47
Marital reconciliation	45
Retirement	45
Major ill health of a family member	44
Pregnancy	40
Sexual difficulties	39
Addition in the family (Birth of a baby; parent or another member moving in)	39
Business readjustment	39
Change in financial state	38
Death of a close friend	37
Change in vocation	36
Increased arguments with spouse	35
Taking a large mortgage or loan	31
Foreclosure of a mortgage or loan	30
Change in work responsibilities (promotion, lateral movement)	29
Son or daughter leaving home (getting married, going to college/ boarding school)	29
Trouble with in-laws	29
Outstanding personal achievement	28
Spouse begins or stops work outside the home	26
Starting or completing school/college education	26
Major change in living conditions (building a new home, remodelling home)	25
Major change in personal habits (dress, associations, etc)	24
Trouble with the boss	23
Major change in working hours	20
Change in residence	20
Changing to a new school/college	20
Major change in recreational habits	19
Major change in religious activities	19
Major change in social activities (watching movies, going to theatre, going to a club, visiting people; if used to not being able to)	18
Taking a small loan	17
Change in sleep (Less or more hours/change of hours)	16
Change in number of family get-togethers (a lot less/ lot more than usual)	15
Major change in eating habits (a lot more or lot less than usual; or change in meal hours)	15
Vacation	15
Major festival	12
Minor violation of the law (traffic tickets)	11
Total score	

*Adapted From Thomas Holmes & Richard Rahe's *Life Events Scale*

What does the score mean?

Sum up the score and match with the predictive risk given below:

Less than 150 points	30 per cent probability of developing an illness, i.e., no more than average risk
Between 151 and 199 points	37 per cent probability of developing an illness
Between 200 and 299 points	50 per cent probability of developing an illness
300 or more points	70 per cent probability of developing an illness

If you find yourself at the wrong end of this score, try and ensure that you do not make any major life changes consciously if you can help it, at least for the next one year.

(To be continued in the next issue)

Recent Development in Science and Technology

□ Biman Basu

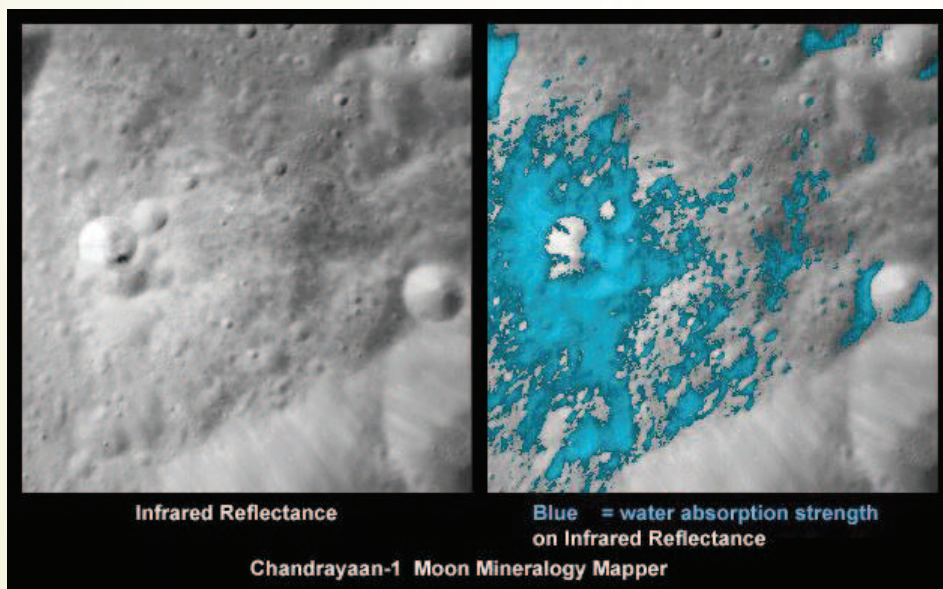
e-mail: bimanbasu@gmail.com

Chandrayaan-1 confirms water on Moon

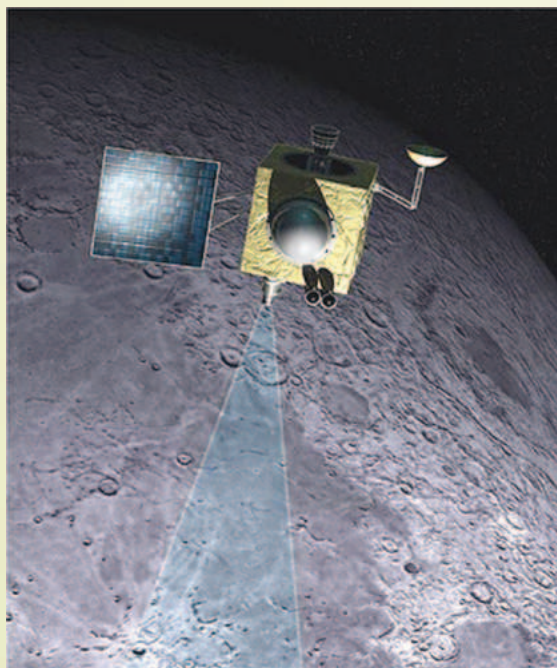
Before its untimely demise in August – 14 months ahead of its planned end of mission – India's *Chandrayaan-1* had sent back heaps of valuable data and photographs that have revealed for the first time that our Moon indeed has water. This is contrary to earlier beliefs that the Moon is bone dry. Early studies on the lunar samples returned by the *Apollo* missions had revealed total absence of the water-bearing primary minerals such as gypsum, chalcantinite, epsomite, melanterite, etc. that are common in Earth rocks; instead, all the Moon rocks examined were composed entirely of anhydrous minerals.

The prime objective of *Chandrayaan-1*, India's first mission to Moon, was to finding traces of water on the lunar surface besides mapping minerals and chemicals on the Moon. To

on the lunar surface on 14 November 2008. But the confirmation came only after the analysis of the huge volume of M3 data was carried out by a joint team of scientists from US and India. The lead role was taken up by Dr. Carle Pieters, Principal Investigator from Brown University, USA and Prof. J N Goswami, Principal Scientist, *Chandrayaan-1* from



These images show a very young lunar crater on the side of the Moon that faces away from Earth, as viewed by NASA's Moon Mineralogy Mapper on the Indian Space Research Organization's Chandrayaan-1 spacecraft. On the left is an image showing brightness at shorter infrared wavelengths. On the right, the distribution of water-rich minerals (light blue) is shown around a small crater. Both water- and hydroxyl-rich materials were found to be associated with material ejected from the crater. [Credits: ISRO/NASA/JPL-Caltech/USGS/ Brown Univ.]



Artist's impression of Chandrayaan-1 in Moon orbit.

achieve this objective, the spacecraft carried a host of sophisticated instruments including the Moon Impact Probe (MIP), the Moon Mineralogy Mapper (M3), and Miniature Synthetic Aperture Radar (Mini-SAR). Although the mission ended prematurely, excellent quality of data were obtained from all these instruments. While M3 has covered nearly 97% of the lunar surface, some of the other instruments have covered more than 90%.

The first indication of water on Moon is reported have come from the Moon Impact Probe, which was made to crash

Physical Research Laboratory of India's Department of Space. The findings were published in the online edition of the journal *Science* on 24 September 2009 (doi: 10.1126/science.1178658), doi: 10.1126/science.1179788, and doi: 10.1126/science.1181471).

While in lunar orbit, M3's state-of-the-art spectrometer measured light reflecting off the Moon's surface at infrared wavelengths, splitting the spectral colours of the lunar surface into small enough bits to reveal a new level of detail in surface composition. This enabled identification of the presence of various minerals on the lunar surface that have characteristic spectral signature at specific wavelengths.

The path-breaking discovery was made after detailed analysis of the data obtained from M3, which clearly showed

a marked signature in the infrared region of 2.7 to 3.2 micron in the absorption spectrum, providing a clear indication of the presence of hydroxyl (OH) and water (H₂O) molecules, extending from lunar poles to about 60° latitude. The M3 team found water molecules and hydroxyl at diverse areas of the sunlit region of the Moon's surface, but the water signature appeared stronger at the Moon's higher latitudes. However, the amount of water present in lunar soil may be extremely small. If all the water in one tonne of the top layer of the Moon's surface is extracted it may amount to less than a litre.

Following the findings from *Chandrayaan-1*, the scientific team had another look at the data from NASA's *Deep Impact* mission launched in 2005 which carried an instrument similar to M3 and found similar indications for presence of water. Re-examination of the data of lunar observation in 1999 by another NASA mission, *Cassini*, while on its way to Saturn also confirmed the presence of both OH and H₂O molecules on the lunar surface.

Ancestry of Indians revealed

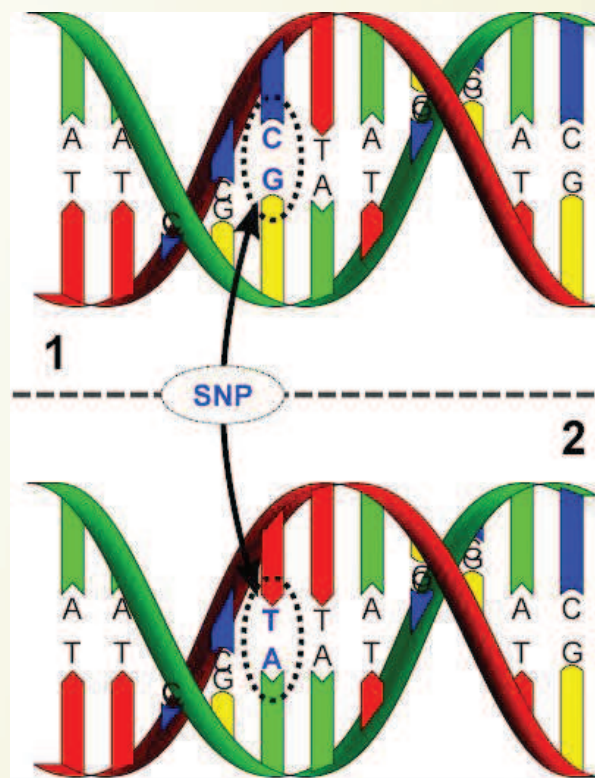
A remarkable study involving the analysis of DNA of randomly selected individuals from 25 diverse ethnic and tribal groups in India has revealed that the country's 1.2 billion population has evolved from only a couple of ancient populations that are as genetically distinct from each other as they are from other Asians. The study was carried out by a team led by Lalji Singh of the Centre for Cellular and Molecular Biology in Hyderabad, India, and David Reich of the Broad Institute in Cambridge, Massachusetts, USA, and their findings were published in the journal *Nature* (24 September 2009).

The researchers analysed the occurrence of minor variations in a single nucleotide in DNA sequence, called single nucleotide polymorphisms (SNPs), in the human genome. After analysing more than 560,000 SNPs across the genomes of 132 Indian individuals from 25 diverse ethnic and tribal groups, the

researchers found that most Indian populations are genetic admixtures of two ancient but genetically divergent groups, which each contributed around 40-80 percent of the DNA to most present-day Indians. According to the study, one ancestral lineage, dubbed 'Ancestral north Indians' - genetically similar to Middle Eastern, Central Asian and European populations - was higher in upper-caste individuals and speakers of Indo-European languages such as Hindi. The other lineage, dubbed 'Ancestral south Indians', was not close to any group outside the Indian subcontinent, and was most common in people indigenous to the Andaman Islands. This pattern applied to all castes within India and to traditional tribes as well. Each of these groups was derived from separate founding populations, according to the analysis. These founding populations arrived in South Asia between about 200 and 2,500 years ago. According to the researchers, this supports the view that castes grew directly out of tribal-like



Onge hunter-gatherers living on the Andaman Islands in the Indian Ocean display purely Ancestral South Indian ancestry and possess direct genetic links to modern humans that left Africa around 70,000 years ago.



A single nucleotide polymorphism (SNP) is a change of a nucleotide at a single base-pair location on DNA.

organizations during the formation of Indian society.

The researchers also found that Indian populations were much more highly subdivided than European populations. But whereas European ancestry is mostly carved up by geography, Indian segregation was driven largely by caste and there are populations in India that have lived in the same town and same village for thousands of years without exchanging genes. Many groups in India share an unusually large number of DNA alterations at precise spots. These findings fit a scenario in which many Indian populations were founded by small numbers of people that married and reproduced within their own groups. According to the researchers, this has clinical implications, as there will be a lot of recessive diseases in India that will be different in

each population and that can be searched for and mapped genetically.

In one exception to the pattern of genetic mixture in Indian groups, the researchers found that the Onge hunter-gatherers living on the Andaman Islands in the Indian Ocean display purely Ancestral South Indian ancestry. They possess direct genetic links to modern humans that left Africa around 70,000 years ago and eventually colonised what is now India.

DNA replacement can prevent genetic diseases

Mitochondria are found in all eukaryotic cells and contain their own genome. Unlike the nuclear genome, which is derived from both the egg and sperm at fertilisation, the mitochondrial DNA in the embryo is derived almost exclusively from the egg; that is, from the mother and is passed to successive generations. The fact that mitochondrial DNA is inherited only from mother enables researchers to trace maternal lineage far back in time. But mutations in mitochondrial DNA are known to cause a diverse range of currently incurable human diseases and disorders. In recent years, researchers have identified more than 150 harmful mutations in mitochondrial DNA, some of which can cause serious and debilitating diseases. Some estimates report that 1 in 6,000 people may have inherited a mitochondrial DNA disorder. Now scientists may have found a way to prevent the transfer of serious inherited mitochondrial diseases from mother to child by replacing the mitochondrial DNA. Now scientists may have found a way to prevent the transfer of serious inherited mitochondrial diseases from mother to child.

A team of American researchers have developed an experimental technique with the potential to prevent a class of hereditary disorders passed on by mitochondrial DNA from mother to child. The technique, as yet conducted only in Rhesus monkeys (*Macaca*



These twin Rhesus monkeys, born on 24 April 2009, developed from cells with donor mitochondrial DNA, a technique that may halt the transmission of certain kinds of inherited diseases. Mito (*left*) and Tracker (*right*) were named for a dye called mitotracker, which labels mitochondria. [Credit: Oregon National Primate Research Center at OHSU]

mulatta), involves transferring the hereditary material DNA from the nucleus of one female's egg into another (donor) female's egg from which the nuclear DNA has been removed. The eggs were then fertilised with sperm and implanted into females, which produced offspring that had mitochondrial DNA from one female and nuclear DNA from another. The researchers found no traces of the original egg cells mitochondrial DNA in the offspring, indicating that the process successfully prevented its transfer (*Nature*, 17 September 2009).

The technique raises the possibility that mitochondria associated with a hereditary disorder could be prevented from being passed on to the next generation. Using the technique, the researchers created fertilised eggs and achieved three successful pregnancies in rhesus monkeys, which have resulted in four healthy newborns. The researchers said that the technique did not appear to pose any risk of chromosomal damage. Analysis of cells from the infant monkeys born after the procedure failed to detect

any mitochondrial DNA from the mother. The research was funded by the US National Institutes of Health.

New element named copernicium

The element 112 was discovered 13 years ago by an international team of scientists led by Sigurd Hofmann at the Institute for Heavy Ion Research in Darmstadt, Germany. As per the nomenclature adopted by the International Union of Pure and Applied Chemistry (IUPAC), the element was given the tentative name 'ununbium'. Recently IUPAC has officially recognised the discovery and recognised the new element as a member of the periodic table. Discoverers of element 112 have named the new element 'copernicium' after the 16th century Polish astronomer Nicolaus Copernicus, who is remembered for his revolutionary theory of Sun-centred universe. The symbol 'Cp' has been suggested for the new element.

Element 112 is the heaviest element in the periodic table – 277 times heavier

than hydrogen. It is produced by a nuclear fusion, by bombardment of zinc (at. no. 30) ions onto a lead (at. no. 82) target. As the element is extremely short-lived and decays after a split second, its existence can only be proved with the help of extremely fast and sensitive analysis methods. Twenty-one scientists from Germany, Finland, Russia and Slovakia were involved in the experiments that led to the discovery of the new element.

46 Ni Nickel 58.6934	47 Cu Copper 63.546	48 Zn Zinc 65.39	49 Ga Gallium 69.723	50 Ge Germanium 72.64
78 Pt Platinum 195.08	79 Au Gold 196.9665	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2
110	111	112 Cp Copernicium (277)		

The position of copernicium in the periodic table.

As only a few atoms of copernicium have ever been made, its reactivity with other elements is unknown. However, its behaviour can be expected to be similar to that of mercury (immediately above copernicium in the periodic table) and cadmium (two places above).

Oil from diatoms

Diatoms are a major group of eukaryotic (cells with nucleus) algae, and are one of the most common types of phytoplankton. These one-celled creatures are not really plants, but share one very important characteristic with them – they take light from the Sun and

convert it into energy. Although most diatoms are unicellular, they can also exist as colonies. Today, most scientists agree that oil that drives today's world economies comes from diatoms and not from dinosaurs. Now researchers Richard Gordon of the University of Manitoba, Winnipeg, Canada and T. V. Ramachandra *et al.*, of the Indian Institute of Science, Bangalore have come out with a surprising new solution to the global energy crisis - "milking" oil from the tiny diatoms. In a paper published in *Industrial & Engineering Chemistry Research* (1 October 2009), they propose a novel scheme of growing and extracting oil from diatoms.

The authors present a simple line of reasoning: (a) geologists claim that much crude oil comes from diatoms; (b) diatoms do indeed make oil; (c) agriculturists claim that diatoms could make 10-200 times as much oil per hectare as oil seeds; and (d) therefore, sustainable energy could be made from diatoms. They propose three methods: (a) biochemical engineering, to extract oil from diatoms and process it into gasoline; (b) a multi-scale nano-structured leaf-like panel, using live diatoms genetically engineered to secrete oil (as accomplished by mammalian milk ducts), which is then processed into gasoline; and (c) the use of such a panel with diatoms that produce gasoline directly. The latter could be thought of as a 'solar panel' that converts light to gasoline rather than electricity or heat.

The diatom *Didymosphenia geminata* has garnered increased attention as a nuisance and invasive species in freshwater systems. Historically described as rare yet



A diatom of *Navicula sp.*, showing an oil droplet.
[Credit: Charles J. O'Kelly]

cosmopolitan, a suspected new variant of *D. geminata* has the capacity to inundate kilometres of river bottom during a bloom. According to the authors, a better understanding of the physiology and genetic manipulation of this species may open up the way to its commercial exploitation.

According to estimates, The per unit area yield of oil from diatoms is estimated at between 56,000 to 225,000 litres per hectare per year, which is 7-31 times greater than the next best crop, palm oil. This is because diatoms, unlike other oil crops, grow extremely rapidly, and some can double their biomass within 5 hours to 24 hours. However, according to the researchers, more research needs to be done to learn how to make diatoms that both grow quickly and have very high oil content.

Nobel Prizes 2009

The Nobel Prizes in science for 2009 have been shared by nine scientists for their achievements in different fields. The Nobel in Physics for 2009 has been awarded jointly to Charles K. Kao of Standard Telecommunication Laboratories, Harlow, UK, and Chinese University of Hong Kong; and Willard S. Boyle and George E.

Carol Greider of Johns Hopkins University School of Medicine in Baltimore; and Jack Szostak of Massachusetts General Hospital in Boston, “for the discovery of how chromosomes are protected by telomeres and the enzyme telomerase.”

Interestingly, the Nobel in Chemistry for 2009 has also been awarded for pathbreaking research in life sciences – the working of ribosomes in living cells. The



Charles K Kao



Willard S. Boyle



George E. Smith



Elizabeth Blackburn



Carol Greider



Jack Szostak



Venkataraman Ramakrishnan



Thomas A. Steitz



Ada E. Yonath

Smith of Bell Laboratories, Murray Hill, NJ, USA. Kao will receive half of the prize money “for groundbreaking achievements concerning the transmission of light in fibres for optical communication” while Boyle and Smith will share the other half “for the invention of an imaging semiconductor circuit – the CCD sensor.”

2009 Nobel in Physiology or Medicine will go to three American geneticists - Elizabeth Blackburn of the University of California, San Francisco;

prize has been awarded jointly to Indian-born Venkatraman Ramakrishnan of MRC Laboratory of Molecular Biology, Cambridge, UK; Thomas A. Steitz of Yale University, New Haven, CT, USA; and Ada E. Yonath, Weizmann Institute of Science, Rehovot, Israel, “for studies of the structure and function of the ribosome.”

[Details of the prizewinning works will be published in the forthcoming issues.]

Letters to the Editor

Thought provoking editorials

I have been reading the magazine *Dream 2047* for the last 15 months. I found it quite useful and also inspiring to both teachers and students of science. Your editorials are thought-provoking, informative and above all make interesting reading. You touch upon latest happenings in science and technology which is required for all those involved in science education. The articles also appear to be specially written to encourage students and teachers and motivate them to work in basic sciences. No doubt it is one of the finest magazines dedicated to popularisation of basic sciences in our country. You have been doing a commendable job in spreading the scientific spirit among educational institutions in India.

Dr. V. V. Bhaskar

v_bhaskar_v@yahoo.com

Useful for popularising science

The magazine is very useful for popularising science. The articles are pertinent for young readers and encourage them to look for details of science. I appreciate the work of the team responsible for bringing out the magazine.

Vinod Kumar Sainewar,
Principal,

Jawahar Navodaya Vidyalaya,
Talaja, Dist. Bhavnagar (Gujrat)
vinodanu1988@rediffmail.com

Duplication of photographs

I enjoy reading *Dream2047* because it is highly informative. The August issue was remarkable with the photographs of total solar eclipse of 22 July 2009. But I found photographs printed on the cover page also printed in the inner pages too. As a magazine with limited number of pages such duplication is best avoided.

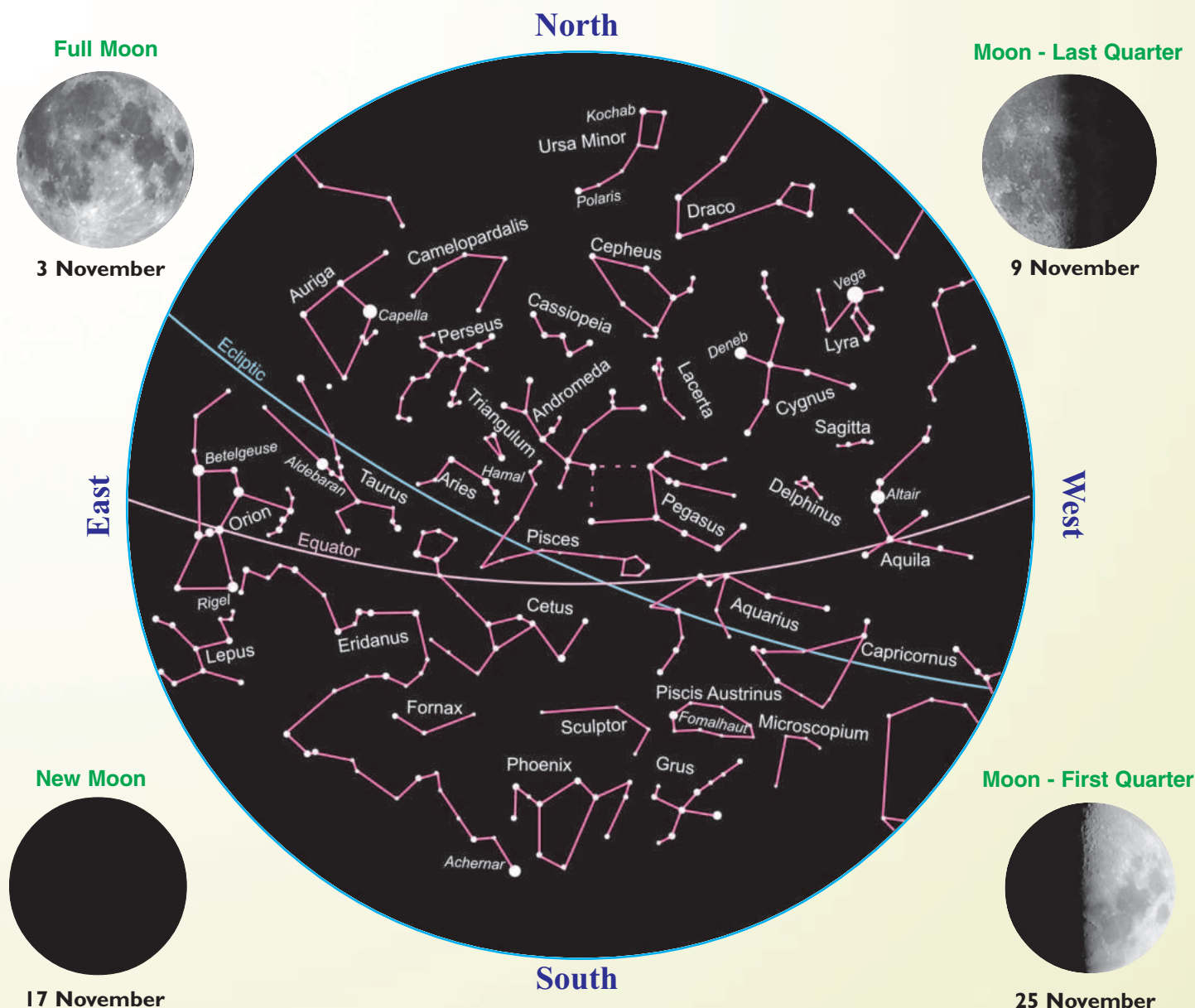
P.P. Muneer,

Pallyvakkath, Near Mahe,

PIN: 673 309

muneer_astronomy@yahoo.com.au

Sky Map for November 2009



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 northern 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 November, at 9 PM on 15 November and at 8 PM on 30 November.



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 Planets¹ (IST)

	Rising	Setting	In the Zodiac
Mercury	06:51	17:50	Virgo-Libra-Scorpius
Venus	05:22	16:45	Virgo-Libra
Mars	23:05	12:12	Cancer
Jupiter	12:25	23:37	Capricornus
Saturn	02:42	14:44	Virgo
Uranus*	14:13	02:09	Aquarius
Neptune*	12:40	23:44	Capricornus

¹Time shown is subject to vary (± 1 hr) from place to place.

*Not naked eye object

Sky Event

Date	IST	Event
05	13:15	Mercury at Superior Conjunction
07	13:00	Moon at perigee
09	11:29	Moon-Mars
23	01:37	Moon at apogee
24	03:40	Moon-Jupiter

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

they passed by – *Deep Impact* spacecraft (launched in 2005) and *Cassini* (launched in 1997).

The Moon Mineralogy Mapper (M3) on board *Chandrayaan-1* detected light reflected off the Moon's surface in the infrared part of the electromagnetic spectrum that indicated the chemical bond between hydrogen and oxygen – the telltale sign of either water (H₂O) or hydroxyl (OH). Because M3 could only penetrate the top few millimetres of lunar soil, the newly observed water seems to be at or near the lunar surface. M3's observations also showed that the water signal got stronger toward the polar regions. *Cassini*, which passed by the Moon in 1999 on its way to Saturn provided confirmation of this signal with its own slightly stronger detection of the water/hydroxyl signal. The *Cassini* data showed a global distribution of the water signal, though it also appeared stronger near the poles (and low in the lunar maria, that is, "lunar seas"). Finally, the *Deep Impact* spacecraft, as part of its extended *EPOXI* mission and at the request of the M3 team, made infrared detections of water and hydroxyl as part of a calibration exercise during several close approaches of the Earth-Moon system *en route* to its planned flyby of comet 103P/Hartley 2 in November 2010. *Deep Impact* detected the signal at all latitudes above the 10° North latitude. Again, the poles showed the strongest signals. With its multiple passes, *Deep Impact* was able to observe the same regions at different times of the lunar day. At noon, when the Sun's rays were strongest, the water feature was lowest, while in the morning, the feature was stronger.

These observations of the Moon not only unequivocally confirmed the presence of water/hydroxyl on the lunar surface, but also revealed that the entire lunar surface is hydrated during at least some portion of the lunar day. Data from *Chandrayaan* show that although the water is present mostly at the poles, it is also thinly spread over the surface up to about 10° south and north of Moon's equator. It appears that the water evaporates as the Sun heats up the surface in the Moon's daytime and condenses back in the night. In some of the polar craters, where sunlight has not reached for the past 3-4 billion years, the water could exist as ice, since the temperatures are about 240° Celsius below

the freezing point of water (or 33° Kelvin) – the coldest region in the entire solar system as observed by NASA's *Lunar Reconnaissance Orbiter* (LRO) in September 2009 (launched in 2008).

Now that we know that the Moon is not entirely dry, the question that arises is – how did the water get there? There are two possibilities. First, the water was brought from outside sources, such as meteorites and comets striking the surface of the Moon. True, bulk of the water may have been lost, but some still may have remained. The second possibility is that the water originated on the Moon itself. This second "endogenic" source is thought to be the result of the interaction of the solar wind with Moon rocks and soils. The solar wind – the constant stream of charged particles emitted by the Sun – consists mostly of protons, or positively charged hydrogen atoms travelling at one-third the speed of light. The rocks and lunar soil that make up the lunar surface are about 45 percent oxygen combined with other elements – mostly silicate minerals. When the protons in the solar wind hit the lunar surface with enough force, they break apart oxygen bonds in soil materials. Where free oxygen and hydrogen exist there is a high chance that trace amounts of water will form. Further, various studies also suggest that the daily cycle of dehydration and rehydration of the lunar surface by this trace water could lead to the migration of hydroxyl and hydrogen towards the poles where it can accumulate in the cold traps of the permanently shadowed regions. The temperature of 33° Kelvin is cold enough to trap stray water molecules over the eons from the impact of comets or asteroids on the Moon or water that is produced on the Moon itself due to the interaction with the solar wind.

Water, it would seem, is being constantly generated all over the lunar surface. Much of it may well boil off into space and some of it may percolate deeper down into the soil; but some of the water would certainly end up at the bottom of the shadowed and deep polar craters. Perhaps the most valuable result of these new observations is that they prompt a critical re-examination of the notion that the Moon is dry. It is not.

The new findings based on the observations of *Chandrayaan-1*, *Cassini*, and

Deep Impact spacecraft were published in the 25 September 2009 issue of the journal *Science*, and came in the wake of further evidence of lunar polar water ice by NASA's *Lunar Reconnaissance Orbiter*. Just two weeks later, on 9 October 2009, NASA's *LCROSS* satellite crashed on one of the permanently shadowed craters at the Moon's South Pole in a controlled manner in the hope of churning up evidence of water ice deposits in the debris thrown up. However, no spray of dust and debris could be seen. The scientists are looking for spectroscopic changes detected around the impact site. Determining whether it was water may take weeks or months of data analysis. The Moon, however, remains drier than any desert on Earth, and the water is said to exist on the Moon in very small quantities. One tonne of the top layer of the lunar surface would hold only about one litre of water.

Water exists on many bodies in our solar system – on planets and also on their numerous satellites. But finding it on our own Moon is certainly awe-inspiring. First, it adds to our knowledge of how cosmic processes work. And next, it could open the way to utilising the water on Moon for making hydrogen and oxygen for meeting requirements of fuel and sustaining life. It could even pave the way towards using the Moon as a base camp for space exploration in the years to come. Could it happen in practice? Let us remember that the discovery of a molecular layer of moisture on the lunar surface is still a long, long way from any practical utilisation.

It is the search for survival options that prompts humankind to strive for more sophisticated technology, effective medicine, and exploration of space for water and earth-like planets. It is imperative that we remind ourselves that the mysteries of the cosmos are far more profound than fulfilment of human needs. It is not even clear when humans might next go to the Moon, let alone set up bases there. Missions of space exploration cannot (and should not) be judged by any immediate returns they may produce. The excitement over such voyages alone is what could propel us towards better understanding of the world around us and the universe beyond.

□ Vinay B. Kamble

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:

"Does the discovery of water on Moon by Chandrayaan-1 open up the possibility of colonising Moon in the near future?"

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* November 2009" should be clearly written on the envelope.



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Winners of "Your Opinion" contest for August 2009.

Topic: "Do astrologers serve any useful purpose in society?"

SOUMYA RANJAN SAHOO

S/o Brajabandhu Sahoo
At – A.E.F. Colony,
Qr. No. 22 34/3,
Sunabeda – 1,
District – Koraput – 163001
(Orissa)



"It can rightly be said that "science moulds our future." How can astrologers predict our future while science comes out with entirely unexpected developments that deeply influence our life? Very often astrologers advise the people to perform ritual acts in order to change their future. It implies that our future is changeable, which it is certainly not as astrologers would have us believe. So astrologers have no useful purpose in society."

MEHRAJ AHMED DAR

S/o Gh. mohi-ud-Din
P/o – Ashmuji Mirpora
Dist. Kulgam (J&K)
PIN – 192231
Email: mehraj.dar153@gmail.com



"Astrology is nothing but an ancient superstition, which is used by some people to deceive others and to frighten them. Astrologers merely use it as a convenient method to loot people. The contemporary society is civilised and educated one wherein science has left nothing untouched. For us, planet Venus means planet Venus and nothing more! There is need to eclipse astrology using the very assets of science."

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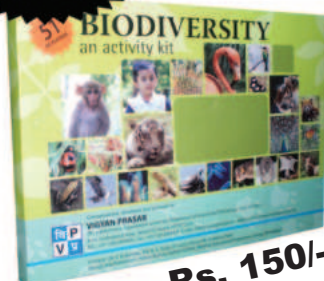
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