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Mendel
The founder of genetics

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Wireless Communication
Much More to Come

In 1895, Jagdis Chandra Bose gave a demonstration of wireless communication in Kolkata Town Hall by transmitting radio waves from the lecture hall through intervening walls covering a distance of 25 metres. It tripped a relay, which threw a heavy iron ball, fired off a pistol, and blew a small mine. Later, Guglielmo Marconi was granted patents for his "wireless telegraph" in 1897. The radio signals, however, could travel only a few kilometres then. Further, only one transmitter and one receiver could operate in any one area. Surely, the future of radio waves appeared quite modest. Since 1900, however, the amount of information that can travel over the same portion of radio waves, called the spectrum efficiency, has improved a trillion times as estimated by Martin Cooper, hailed as the father of the mobile phones.

Remember the good old radio some fifty years ago in your living room? It was a wireless device – a big, wood-panelled machine that faintly glowed and occupied a lot of space. The invention of transistor in 1947 and microprocessor in 1958 brought about a revolutionary change in the way radios functioned. Incidentally, microprocessors integrate transistors and other components onto a single chip. Microprocessors helped get rid of bulky vacuum tubes, crystals and copper coils, and put the assembly of a radio almost entirely on silicon – the second most abundant element on Earth after oxygen. The advantage was that it cost less to manufacture, consumed less power, and allowed the radio to perform better. Today's wireless device is the sleek mobile phone perched in your pocket! What made it possible? It became possible due to the cross-breeding of Marconi's radio and the microprocessor. This is popularly called convergence of technologies and today it implies convergence of radio, microprocessor, internet and other communication technologies.

Over the years, we have witnessed how quickly the innovations occur. The processing power of the chips doubles about every two years according to Moore's law, co-founder of Intel, the world's biggest chip company. As the size of transistors gets smaller, there is more room to add more functions. Such chips are faster and do much more. Further, the cost of integrating new functions is relatively low. Microprocessors brought in a computing revolution. But, this revolution was mainly about information that involved digitizing documents, photographs and records in order that they could be manipulated effectively. On the other hand, the revolution in wireless communication we are experiencing today is about making digital information about *anything* available *anywhere at minimal cost* that would *not* involve wires and cables. In this way, more information about more things could flow to the place where it is required most.

Despite the fact that radio is 110 years old and the microprocessor only about 50, both the technologies are moving ever closer together with wireless capabilities now being put on computer chips. Needless to say, all the benefits of the computing technology, say, innovation, fast development and low cost automatically become available to wireless communication. The new technology enables control to be exercised from a distance and lets different devices interconnect to do something new and interesting!

At present mobile phones have been getting the most attention. About 3 billion are in use as of now, and 1.6 million are being added every day. What is interesting to note is that the mobile connectivity is spilling over into other areas of wireless communication and is used for linking machines, sensors and objects. Wireless communications have effectively linked the people through mobile phones, but, there are far more things that can be wirelessly linked, from doors to windows to machines, trees and farmlands! Indeed, a large number of hitherto unconnected objects are getting wirelessly connected to networks – from televisions and cars to industrial machinery, and even mousetraps!

In years to come, wireless communications between machine to machine – M2M communications as it is called – will increasingly become part of the fabric of everyday life. After all, there are 6 billion people in the world and 50 billion machines! M2M devices use integrated cellular radios to exchange

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Gregor Mendel

Founder of the Science of Genetics

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"In the long term Mendel was successful; he laid a foundation for the science of genetics. In another sense he was a failure; he did not succeed in examinations and his research was largely ignored until 16 years after his death."

The Cambridge Dictionary of Scientists (2002)

"Mendel's work is now recognized as providing the first mathematical basis to genetics but in its day it stimulated little interest. He read a brief account of his research to the Brunn Natural History Society in 1865 and asked members to extend his methods to other species, but none did."

A Dictionary of Scientists, Oxford University Press, 1999

Gregor Mendel, an Austrian monk, was the first to undertake a systematic study of the transmission of hereditary traits and to interpret the results mathematically. Mendel was a contemporary of Charles Darwin, the founder of the theory of evolution by natural selection. When Mendel was carrying out his investigations on the way characteristics are passed on from one generation to the next, Darwin was also giving final shape to his theory of evolution. Darwin was totally unaware of Mendel's work. It was not Darwin's fault. In fact in Mendel's lifetime only a handful of scientists were aware of his work. Mendel was not in the mainstream of the scientific world. He published his results in the *Proceedings of the Brünn Society of Natural History*, a journal, which was obscure. Mendel came to know about Darwin's work at a time when he had given up scientific research because of his involvement in administrative duties as Abbot of a monastery. He was elected Abbot in 1868.

Perhaps many people do not know that Mendel was considered an authority of his time on meteorology. He was a member of the Vienna Meteorological Society. He used to make meticulous record everyday of meteorological data including temperature, rainfall, and air pressure. He also recorded wind direction and wind force. He started his observations in 1857 and maintained meticulous records. He presented a graphical summary of his data to the Natural Science Society in1862. Mendel's approach to meteorological observation was very much popular among other amateur meteorologists. Based on his statistical data Mendel even attempted to

Gregor Mendel

forecast weather for local farmers. In1870, he wrote a paper describing the causes of tornadoes. Mendel was elected a member of Brno Agricultural Society in 1863. He studied heredity in bees. He was a member of the Society of Apiculturists.

Gregor Mendel, whose original name was Johann Mendel, was born on 22 July 1822 in Heinzendorff, then part of the Habsburg Empire. Today Heinzendorff is called Hyncice and is located in the Czech Republic. Mendel's father, a small farmer, served as a soldier in the Austrian army. His mother, Rosine, was the daughter of a gardener. It was Mendel's mother who instilled a love for plants in him. He displayed intellectual powers at an early age. On the recommendation of his primary school teachers, he was sent to a more advanced Piarist school at Lipnik (then Leipnik), a place 26 kilometres away from his home. In 1834, Mendel joined the gymnasium in Opava (then Troppau) situated about 35 kilometres away from home.

Mendel's aim in life was to become a teacher. With this aim he completed six years of his studies at the gymnasium. For getting enrolled in a university, he had to complete two years of further philosophical studies, but his parents were not in a position to support his further schooling. His father had suffered injuries and so Mendel's help was needed for farming. Mendel had no intention of becoming a farmer. He decided to support himself in his academic pursuit. After earning some money by giving private tuitions to students, Mendel entered the Philosophical Institute at Olomouc (then Olmuz) in 1841. He studied there for two years and became qualified for getting enrolled in a university. However, by this time Mendel had become too tired by his constant struggles to make his two ends meet and so he did not join a university. Instead he entered the Augustinian monastery of St. Thomas at Brno (then

Karl Naegeli

Brünn, the capital of the province of Moravia). Mendel was admitted to the Monastery without any interview because he was strongly recommended by his professor. At the time C. F. Napp was abbot of the monastery.

Mendel started his normal probationary period at the Monastery in October 1843. He took the name Gregor. Though, during the probationary period the major emphasis of Mendel's studies was on classical subjects, in his free time he studied plants and minerals. He also studied agricultural science as part of necessity. The economy of Brno depended mostly on sheep breeding and cultivation of grapes for wine production. After the completion of the probationary period, Mendel was ordained a priest in1847.

Mendel was made a chaplain of the monastery parish in 1848. He was not physically equipped to serve as a chaplain. He himself suffered a nervous break down. The abbot of the monastery took a sympathetic attitude and appointed Mendel as a substitute teacher in the Znojmo Gymnasium in 1849. He was to teach the classics and mathematics to students of seventh standard. He proved to be a successful teacher. However, it was just a temporary appointment. To become a permanent teacher he had to pass a qualifying examination. Mendel appeared for the examination but failed to qualify. This was rather surprising, as Mendel was a brilliant student all along and performed well as a substitute teacher. Of course, it was true that Mendel had no university education and he prepared for the examination on his own. Though he failed to pass the qualifying examination, his reputation as a teacher was well established. So after his term at the Znojmo Gymnasium was over, he was appointed, again as a substitute teacher, at the Brno Technical School. This time he was to teach natural history.

In 1851, C. F. Napp, the abbot of the monastery, sent Mendel to Vienna University so that he could prepare for the teacher's qualifying examination. Mendel studied there for about two years. He took special interest in physics because he was quite impressed by the simplicity of the natural laws of physics. He also learnt the application of probability theory and statistical analysis. Among the other subjects that Mendel studied at Vienna University were chemistry, zoology, botany, plant physiology and paleontology.

In July 1853 Mendel came back to the monastery. He did not reappear for the teacher's qualifying examination immediately after coming back from Vienna University. He appeared for the examination in1855 but failed again. However, he continued to teach. He taught at the Realschule, a non-traditional technical school, for 14 years. At the Realschule, he taught physics and natural history. But it was not a full appointment and he received only half the pay of a normal appointment.

In the second half of the 1850s, Mendel carried out his famous breeding experiments with *Pisum sativum*, or the ordinary garden peas, to determine how traits were passed from generation to generation. The selection of *Pisum* was not accidental. The selection was based on intensive study of the literature and numerous experiments. The reasons for its selection were:

i) This plant was easy to grow.
ii) Pollinations could be easily controlled.
iii) The plants had several easily distinguishable characteristics to examine.
iv) The resulting hybrids were fertile.

A hybrid plant is a new variety of plant created by crossing two varieties or species. The seven characteristics that Mendel chose for analysis were seed shape, seed colour, flower colour, pod shape, pod colour, flower position, and stem length.

After selecting *Pisum* for his breeding experiments, Mendel carried out his methodical pollinations. He started with a single pair of traits. First he pollinated pea-plants with round (or smooth)-shaped seeds with pollen from wrinkle (or rough)-shaped seeds. Mendel found that the seeds produced by the hybrid plants were all round. After this Mendel made a reciprocal cross that is he pollinated pea-plants with wrinkled seeds with pollen from plants with rounded seeds. The result was the same as in the first crossing. All the seeds produced by the hybrid plants were round. The hybrid offspring from the first set of crosses are often referred to as F_1 generation.

In the second phase of his experiment, Mendel planted the round hybrid seeds and allowed the offspring to self-fertilise. The offspring produced by the self-fertilisation (often referred to as F_2 generation) resulted in 5,474 round and 1,850 wrinkled seeds. In the first hybrid generation or F_1 generation there was no wrinkled-seeds and it seemed this trait had altogether vanished. But it reappeared in the second generation or F_2 generation. The trait that survived after the initial set

Hugo de Vries

History of Science

of crosses was called 'dominating' by Mendel (now called 'dominant'). Mendel called the trait that vanished in the first generation 'recessive' (and this term has remained unchanged till today).

Mendel carried out similar experiments to determine the transmittance of the other six traits. In all cases one of the traits was dominant and the other recessive and in the first-generation offspring (or F_1 offspring) the dominant trait was expressed in all cases. However, the second-generation offspring (or F_2 offspring) exhibited a 3:1 ratio of the dominant to the recessive trait.

Mendel's results clearly disproved the then prevalent belief held by many scientists that inherited characteristics were an intermediate form of expression of the parental traits. His results demonstrated that parents' traits were not blended in the offspring. At the time of Mendel the word 'gene' was not in vogue.

Now let us try to understand the results of Mendel's experiments in genetic terms. Each of the original plants with round-shaped seeds carried two genes (strictly speaking two alleles) that specify roundness in the seeds. Similarly in the original plants with wrinkle-shaped seeds, each plant carried two copies of the alleles that specify wrinkle-ness in the seeds. With each variety of the original plants, there will be no problem to guess correctly which version of the gene would be expressed in the phenotype.

But in case of the first generation hybrid offspring this was not so obvious. This is because every cell of a daughter plant carried one copy of the allele for roundness and one copy of the allele for wrinkle-ness. But in spite of this fact the allele expressed in all cases was for the roundness. This happened because the roundness gene was dominant. So if a plant carries that allele it dominates over the other allele or the recessive one. This means every daughter plant produced by crossing plants with round-shaped seeds with plants with wrinkle-shaped seeds and vice versa the roundness trait was expressed in the phenotype. The alternative allele that specifies wrinkle-ness was present but it was not expressed in the phenotype. The recessive trait is expressed only when it is present in both copies of the allele.

In case of F_2 generation, the genes get mixed up in a different manner. Each F_2 generation plant inherits one allele for this characteristic (that is shape of seed) from each parent, and each parent has two different alleles to offer. Statistically there is 50:50 chance of any particular F_2 generation plant inheriting either allele from the one parent, and the same chance of inheriting either allele from the other parent. Now, if we denote roundness allele by A and wrinkle-ness allele by a. The daughter plants or F_1 generation plant will have a genotype that can be expressed as Aa. A member of the next generation plant may have one of four possible combination of this allele that is AA, Aa, aA or aa. Three of the four combinations include at least one roundness allele, which is the dominant allele. This means 75 percent of the F_2 generation plants will have this allele expressed in phenotype. Only one combination has two alleles in each cell specifying wrinkle-ness, and so 25 percent of the F_2 generation plants will have wrinkle-shaped seeds. Mendel found that the characters were inherited in a ratio always close to 3:1. He recognized that the 3:1 ratio of observed characteristics, or phenotypes, was really a disguised 1:2:1 ratio of genotypes. Based on his elaborate experimental results (Mendel handled about 30,000 plants) he proposed that hereditary elements or factors (now called genes) exist and that they determine the characters. He also proposed that these factors segregate from each other in the formation of the germ cells or gametes. Mendel's results were summarized in the form of two laws – law of segregation (Mendel's First Law), and law of independent assortment (Mendel's Second Law). The law of segregation states that the characters of a diploid organism are controlled by alleles occurring in pairs and that of a pair of such alleles, only one can be carried by a single gamete. The law of independent assortment states that each of the two alleles (that is, the two forms) of one hereditary element (gene) can combine randomly with either of the alleles of another hereditary element or gene.

Karl Correns

Mendel's work with peas did not create much interest among scientists of his time. He presented his results before the members of the Brünn Natural History Society in 1865 and asked them to extend his methods to other species, but none paid attention to his suggestions. He published his findings in the *Proceedings* of the Society and sent reprints of his papers to some experts of his day. Karl Naegeli, the Swiss botanist was rather sceptical of Mendel's results and suggested that Mendel should continue work on the hawkweed (*Hieracium*). Later it was found that *Hieracium* show reproductive irregularities, and if Mendel had tried to work on it following the suggestion of Naegeli, he would have failed.

Mendel's data were also questioned. Many thought that his data were not realistic or 'they were too good to be correct'. John Gribbin, one of the most accomplished and prolific science popularisers of present day wrote: "It is important to emphasise that Mendel was no ordinary monk. He came from a poor family, but was highly intelligent and thirsted for academic career in science. The only way he could get any kind of advanced education was to join the priesthood and train as a teacher, In doing so, he studied physics in particular, and he brought to his investigation of heredity the physicists' approach, taking great care to keep his breeding line separate, and with a thorough understanding of the correct way to interpret his results statistically – something which even physicists were only just coming to grips with in the mid-nineteenth century and which was almost unheard of in biology in those days. There is a touch of irony in this because a few years ago some modern statisticians, re-examining Mendel's results, claimed that his results were 'too good to be true' and that he must have fiddled his data. It turned out that these statisticians did not understand the biology properly and had not allowed for the fact that about one in ten of the peas planted by Mendel would have failed to germinate! This story delightfully highlights the fact that Mendel himself understood both biology and statistics."

In 1868, after the death of Napp, Mendel was elected abbot of the monastery. He thought to devote more time for research, as he no longer needed to teach. But it did not happen. The duties of an abbot were too consuming to have spare time for research. Mendel did not receive any recognition for his path-breaking contributions. Mendel died on 6 January 1884. He was cremated in the monastery tomb in the Central Cemetery. Mendel's work remained unexplored until 1900 when Hugo de Vries, Karl Correns, and Eric von Tschermak came across his work and its true significance was realized.


Eric von Tschermak

In 1910, a statue of Mendel was erected outside the monastery in Brno and then in 1922 a sandstone monument was placed in Mendel's experimental garden at the monastery. In 2002, the Mendel Museum of Genetics was established in the Abbey of St. Thomas in Brno.

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(This article is a popular compilation of the important points on the life and work of Gregor Mendel available in the existing literature. The idea is to inspire the younger generation to know about Mendel. The author has given sources consulted for writing the 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.)

Editorial *(Contd. from page 35)*

data with other machines over existing cellular networks. It could be a mobile phone and a computer with Bluetooth connectivity. Virtually any piece of machinery, from electricity meter to a burglar alarm, is suitable for M2M communications. Surely, M2M market is much bigger than the mobile phone market! M2M communications is a new business concept, borne out of the original telemetry technology, used for automatic transmission and measurement of data from remote sources by wire, radio or other means.

Using wireless communications, carmakers have begun monitoring vehicles so that they know when to replace parts before they fail, based on the changes in vibration or temperature. In case of a theft or a crash, wireless chips fitted into the car could tell the emergency services where to come and what has happened. Consider light fixtures in a building. If every fixture contained a small wireless device, it would be possible to control lighting more effectively. If every such device were programmed to serve as online smoke detectors, they could signal a fire and even could show its location. They could even act as a security system or provide Internet connectivity to other things in the building. An interesting example is from Britain in which mousetraps are fitted with a small sensor and a wireless module, and placed in buildings. They can notify the building staff when a rodent is caught! In future, forest rangers could drop sensors from aeroplanes to detect fires, showing their exact location and how fast and in which direction they are spreading. Chips even could be placed inside humans as a means of identification, or to measure body functions and transmit information from inside the body.

In the first half of 20th century, electric motors appeared in every device from eggbeaters to elevators. In the second half, computers monopolized all kinds of different machinery from spacecraft to car and coffee machines. In the next fifty years, M2M wireless technology may well become an integral part of objects. It could be frightening at times, but the results could be immensely useful.

Vinay B. Kamble

How a Rocket Works

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Colourful Diwali rockets that enthral us, missiles that threaten world peace, and the rockets that launch spacecraft have certain things in common: they are basically tubes in which a fuel is ignited to produced hot gases that escape at high velocity and create an explosive thrust that propels them in the opposite direction. They all follow Sir Isaac Newton's Third Law of Motion, which states: "To every action, there is an equal and opposite reaction."

How a rocket works is very similar to how an inflated balloon zigzags across a room when the air is let out from one end. Take an inflated balloon. Hold the opening tightly closed. Air inside the inflated balloon is made up of gases that are pushing equally in all directions. Let go of the balloon and it will fly across the room whizzing past in a zigzag path. Why? As pressurised air from the balloon escapes through the mouth in one direction, the balloon is pushed in the other direction.

Of balloons and rockets

When we think of rockets, we rarely think of balloons. Instead, our attention is drawn to the giant vehicles that carry satellites into orbit and spacecraft to the Moon and planets. Nevertheless, the basic principle is the same. The one significant difference is the way the pressurized gas is produced. In a balloon you pump in the air under pressure. With space rockets, the gas is produced by burning propellants that can be solid or liquid in form or a combination of the two. In a rocket some fuel is burned with an oxidizer in a combustion chamber, creating hot gases under high pressure – analogous to the air in an inflated balloon. In a rocket combustion chamber these gases expand, pushing equally in every direction – like air exerting pressure on the walls of a balloon. In a rocket, a relatively small hole, called the throat, exists at the bottom of the chamber and leads to an exhaust nozzle that flares out like a bell – akin to the mouth of the balloon. The expanding gases come out through the throat and escape through the nozzle at high speed, which makes the rocket engine and the vehicle attached to it – including its fuel and oxidizer (propellant) tanks, plus payload or spacecraft – lift off from the launch pad.

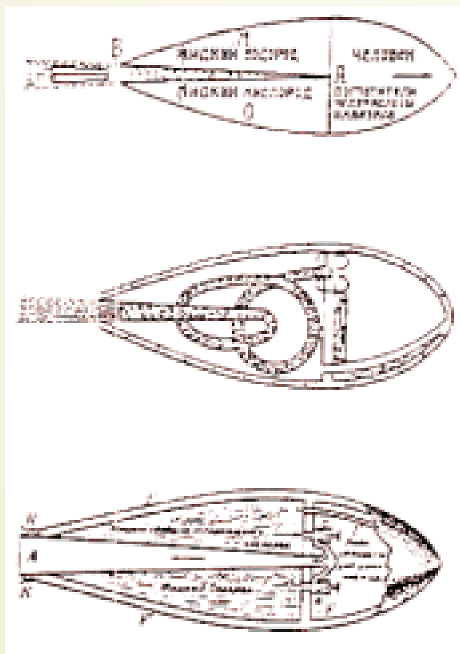

Fig. 1. Tsiolkovsky's rocket designs

Most often it is assumed that an inflated balloon moves forward because the air escaping pushes against the air outside. That is not the case. If so, rockets would be useless in the vacuum of space. Let us again look at an inflated balloon. The inflated balloon is at 'rest' when you hold its mouth, as per the Newton's first law. Every force on the balloon is countered by an opposite and equal force. In the inflated balloon, the pressure of the gases inside is the 'action.' The counter-pressure of the balloon walls holding the gases in is the 'opposite reaction.' When these two factors are in balance, the gas in the balloon remains at rest. The balloon also remains at rest because its weight is balanced by the force you exert to hold the balloon with its mouth shut and because the force exerted by the internal gas on each part of the balloon is balanced by a force of the gas outside of the balloon. Newton's First Law of Motion says in essence: "A body at rest will remain at rest…unless an unbalanced force is exerted upon it."

For the balloon to move you will have to create an imbalance in the forces acting on it. When an opening or nozzle is provided for the gases inside the balloon to escape, an imbalance occurs because the internal gases can escape through this low-pressure area. There is no longer an equal pressure maintaining the balance. The internal pressure of the gases creates an unbalanced force that drives the gases through the opening. The side of the balloon opposite the opening is now experiencing a force that is no longer balanced by an equal and opposite force on the side of the balloon where the opening is. This unbalanced force on the balloon in a direction opposite to the side of the balloon where the internal gases are escaping through the hole makes the balloon move forward. Therefore the rocket principle works both in Earth's atmosphere as well as in the vacuum of space.

Fuels

Rockets use chemicals that can expand manifold when ignited. Historic Chinese fire arrows, Tipu Sultan's rockets, British-made Congreve rockets, or even the Diwali rockets are rockets with solid fuels. They essentially use gunpowder, which, when ignited provides enough exhaust to propel the missile forward. The thrust per weight provided by gunpowder is relatively small; but it was adequate for early missiles. Of course, it would be

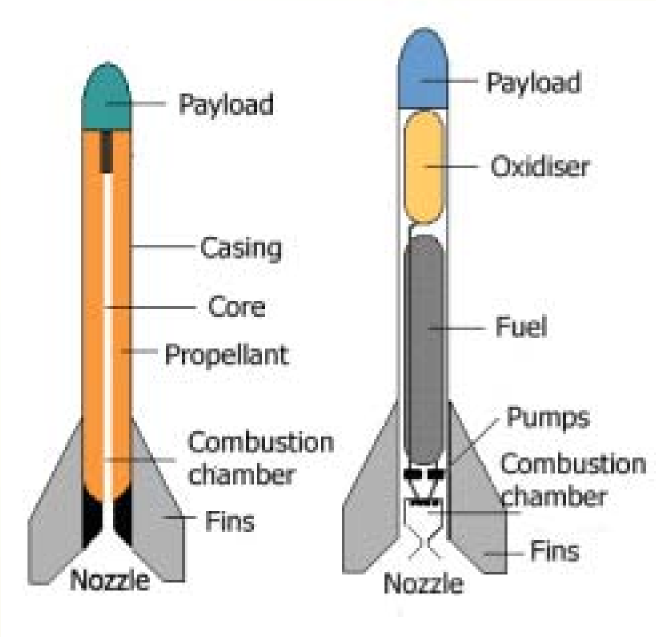

Fig. 2. Solid (left) and liquid propellant (right) rockets

totally useless to lift payloads weighing tonnes.

In modern times semi-solid polymers have been developed as propellants. A polymer, as we know, is made by stringing identical molecules together to create larger molecules without changing the basic chemical composition. It was discovered that mixing a chemical oxidizer and fuel, often aluminium powder, with the polymer to provide the needed oxygen produced a substance with a consistency similar to *chappati* dough. This substance could be moulded into forms and baked into a rubbery solid material that burned furiously when ignited and created large volumes of gases, producing much greater thrust per weight than gunpowder. Even now in solid rockets the propellant mixture is called the 'grain,' a word carried over from gunpowder days.

In other words, in solid rockets the propellant is solid cast. But if the solid cast propellant is ignited it may not burn at the same or desired rate. So one has to find a way to control the burning characteristics of a solid propellant. To meet this demand, a carefully designed hole through the propellant or a 'perforation' is formed when the propellant is cast into the rocket's cavity. By varying the size and shape of the perforation it is possible to determine the rate and duration of combustion and thereby control the thrust.

Liquid fuelled rockets have better specific impulse than solid rockets and are capable of being throttled, shut down, and restarted. Liquid fuelled rockets use an oxidizer – a chemical that allows the fuel that is being used to burn in the vacuum of space – and a propellant – a highly flammable material that actually burns, producing the thrust. In this type of rocket the liquid fuel and oxidizer are stored in separate tanks and are combined only at the moment of combustion. Oxidisers such as liquid oxygen, nitrogen tetroxide, or hydrogen peroxide are combined with a fuel such as kerosene or gasoline in the combustion chamber. The combustion chamber of a liquid fuelled rocket needs to be sturdy enough to withstand combustion pressures and temperatures. The American rocket expert Robert Goddard launched the first liquid-fuelled rocket on 16 March 1926; it used gasoline and liquid oxygen as fuel and oxidiser.

Liquid fuelled rockets also require potentially troublesome valves and seals and combustion chambers, which increase the complexity of the rocket manufacture. Pumps are required to get the fuel and oxidizer to the motor quickly enough to develop the desired thrust. However there are many advantages of liquid rockets. As the pressure of stored liquid fuel is not high much lighter tanks can be used, permitting a larger amounts of the fuel to be carried. Moreover liquid fuel is up to twice as powerful as solid fuels. Also, liquid fuelled rockets can be turned off and then turned on again. Hence liquid fuelled rockets are not only more powerful, but are also more controllable.

The common liquid propellant combinations in use today are LOX (liquid oxygen) and kerosene. Used in the lower stages of most Russian and Chinese boosters, and the first stage of the Saturn-V, this combination is widely regarded as the most practical fuel mix. Nevertheless, the American space shuttle, the Centaur upper stage, the newer Delta-IV rocket, and most stages of the European Ariane rockets use LOX and liquid hydrogen. Nitrogen tetroxide (N_2O_4) and hydrazine (N_2H_4), monomethyldrazine (MMH), or unsymmetrical dimethyl hydrazine (UDMH) are at times used in military, orbital and deep space rockets, because both liquids are storable for long periods at reasonable temperatures and pressures. The *Vikas* liquid propellant engine used in Indian satellite launching rockets use a hydrazine-derived fuel and nitrogen tetroxide (N_2O_4)oxidizer.

Thrust

Whether powered by liquids or solids, rocket systems are propelled by gas pressure resulting from fuel combustion. The force driving them forward is called 'thrust'. If the rocket system – the liquid or solid booster plus payload – is to move upward against gravity the thrust must be greater than gravity's downward pull.

Assume you are holding a ball weighing 1 kg in your palm. In fact you are exerting 1 kg of thrust on the ball. In doing so you are burning fuel and oxygen – the foods you eat and the air you breathe – in your body to exert the energy to cancel the gravitational pull on the ball on your palm. The ball is not going up. If you let it go, the ball will be pulled to the ground by gravity and fall on the ground. Now if you move your hand up with a jerk, the ball will leave your palm and fly upward a bit farther before falling back to the ground. That is, you have provided an impulse to the ball and therefore it flies a distance depending upon the impulse provided by you. While providing the impulse, you have imparted a thrust of more than one kg to the ball. In that you have done something more than to merely cancel gravity for a moment and hence the ball goes up.

A rocket also moves upward in the same way. Its engines develop a thrust at lift-off, which is more than its total initial weight. In fact, the ratio between these two values – thrust produced by the fuel and the weight of the rocket – is called the thrust-to-weight ratio of the booster. In powerful rockets it is usually around 1.2, enough to accelerate a payload. As propellants burn, the thrust-to-weight ratio increases, and the booster continues to accelerate at higher rates.

The way a rocket propels the payload into orbit is similar to the way you made the ball go up. Your hand and arm are, in effect, the rocket with its engines and tanks of fuel and liquid oxygen. The ball is the payload. The upward swing of your hand duplicates the powered-flight phase of the rocket at its launch. The instant you stop your hand is similar to the instant of engine burnout or shutdown, when the rocket's fuel is exhausted or the engines are stopped. From this instant, both the ball and the payload begin decelerating, slowing down in their ascent. Gravity pulls each back toward Earth.

A ball that goes up invariably comes down. If so, how do we put people and spacecraft into orbit around Earth, land on Moon, visit Mars and send spacecraft to other planets? Sure, by exerting more force, or thrust. As the initial thrust is increased the ball travels higher and higher. For a given payload, more and more thrust would mean it would achieve a much higher velocity before the thrust is terminated. It would go much farther away from Earth before gravity succeeds in pulling it back. Velocity, therefore, is a critical factor. For instance, to put an object into orbit around Earth, a velocity of at least 8 kilometres per second must be achieved, depending on the precise orbit desired. This is called 'orbital velocity'. In other words, orbital velocity is attained when the spacecraft is moving in the right direction, fast enough to miss

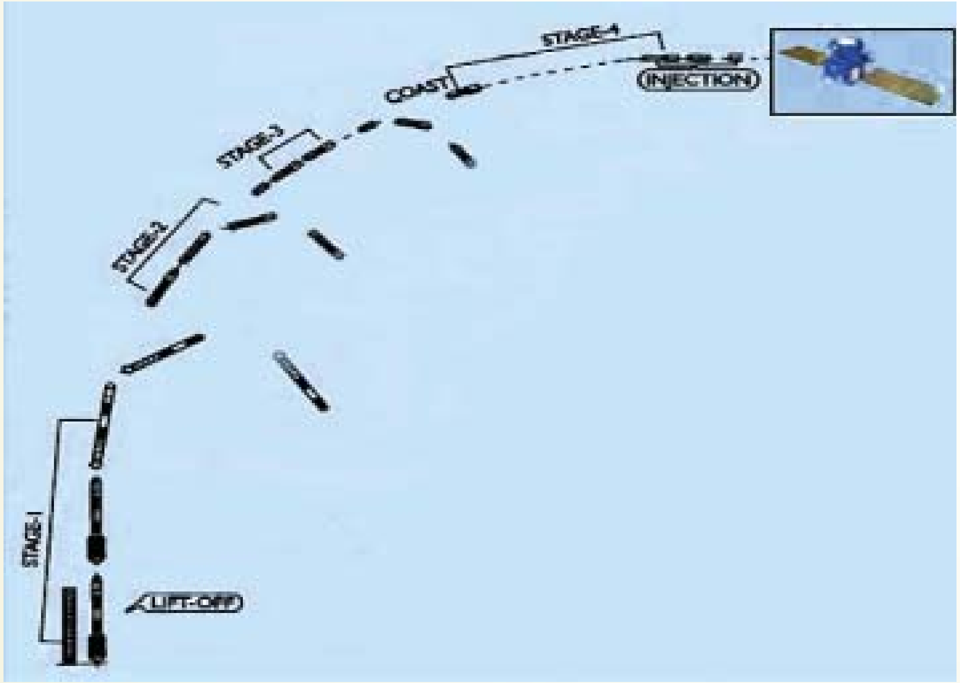

Fig. 3. Path of a multistage rocket

Earth as it falls back. The actual resulting course keeps it in space circling Earth in an orbit like the Moon. In effect, such a spacecraft is falling continually around Earth like the Moon and hence it is called an 'artificial satellite'. On the other hand, to break away from Earth's gravity for distant space missions, a velocity greater than 11 kilometres per second is required. This is called 'escape velocity'.

During the infant stages of space flight the rockets available had less thrust; still remarkable successes were achieved by keeping the payloads as small and as light as possible. *Sputnik-1* weighed 83.6 kg. America's first artificial satellite, *Explorer-1* weighed only 14 kg. The earliest rocket to reach space, V-2 had a lift-off thrust of only 264.900 kilonewtons (kN) and Korolev's R-7 had a thrust of 3,904.000 kN. Bigger and more powerful rockets are available today. America's Saturn-V has a lift-off thrust of 33,737.900 kN, US space shuttle 25,751.600 kN, Russia's re-useable shuttle launcher Energia 35,129.900 kN; Soyuz ST 4,144.700 kN; Proton 9,469.100 kN. India's PSLV has a lift-off thrust of 5,300.000 kN and GSLV 6,810.000 kN.

Staging

The Polar Satellite Launch Vehicle (PSLV), India's third-generation launch vehicle, large enough to carry polar-orbiting earth resources satellites, is a four-stage launch vehicle, whereas the Geostationary Satellite Launch Vehicle (GSLV), Indian launcher for geosynchronous satellites using a liquid oxygen/liquid hydrogen upper stage developed from Russian technology, is a three-stage vehicle. What are these stages?

We know that for sending a given payload farther and farther out into space a higher thrust applied for a longer duration is required. The principles of physics tell us that the longer the thrust is exerted, the faster a rocket would go. For example, provided its mass does not change, a vehicle starting from rest under a constant net thrust will be going 100 times faster after 100 seconds than after the first second.

When a rocket is launched its total mass does not remain the same; it decreases. As each kilogram of propellant is burned, the mass of the ascending vehicle becomes one kilogram less, and large rocket engines may burn hundreds of tonnes of propellant in seconds. As a result, the same thrust has much less mass to accelerate. The decrease in weight allows an increase in acceleration.

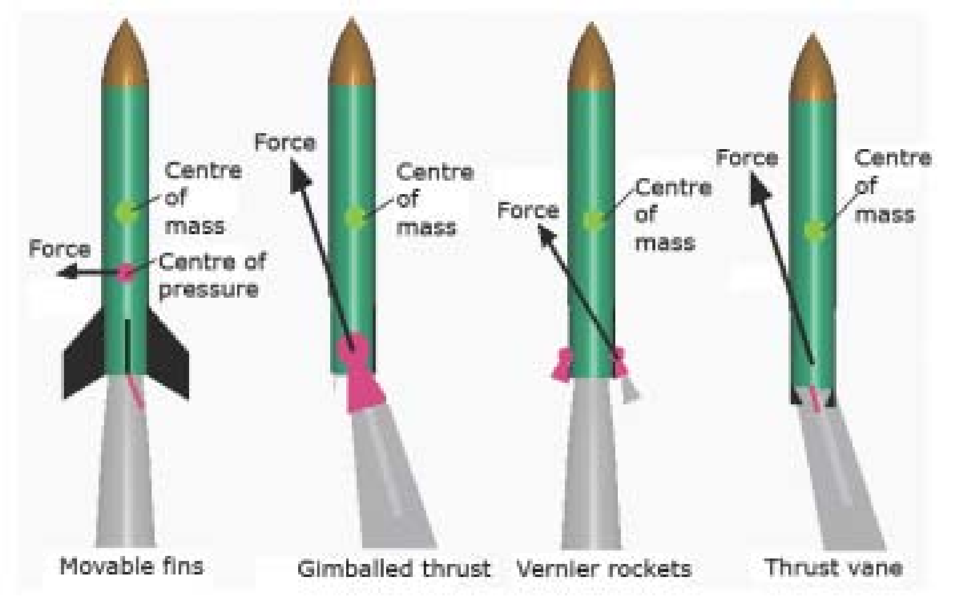

Fig. 4. Different methods of rocket control

This principle is used in the concept of 'staging.' Once the fuel is used up the tank, pumps, and the rocket casing are useless and only add weight to the vehicle, which slows down its future acceleration. If somehow the useless parts could be removed, as their utility is completed, then with less fuel one would be able to achieve higher acceleration of the payload.

A space launch vehicle usually consists of a number of such well-defined sections known as 'stages'. After the first rocket stage accelerates the entire vehicle and finally burns out, its tanks and motors are discarded. By dropping the stages, which are no longer useful, the rocket lightens itself. The thrust of the successive stages is able to provide more acceleration than if the earlier stages were still attached. When a stage drops off, the rest of the rocket would be still travelling near the speed that the whole assembly reached at burnout time. This means that it needs less total fuel to reach a given velocity and/or altitude. The same happens in the second and subsequent stages. The payload is finally all that remains, having been accelerated to the necessary velocity in successive stages.

Packaging the energy of a rocket vehicle into stages that can be discarded as they burn out has been the secret of launching into space. The number of stages may vary from two to five or even more. There are two types of rocket staging, serial and parallel. In serial staging, the second stage, usually a smaller rocket engine is placed on top of a larger first stage engine. The first stage is ignited at launch and burns through the powered ascent until its propellants are exhausted. The first stage engine is then extinguished, the second stage separates from the first stage, and the second stage engine is ignited. The payload is carried atop the second stage into orbit. In parallel staging several small first stages are strapped onto to a central core rocket. At launch, all of the engines are ignited. When the propellants in the strap-on rockets are exhausted, the strap-on's are discarded. The core engine continues burning and the payload is carried atop the core rocket into orbit.

Control

If a balloon's flight is erratic, and Diwali rockets do not soar straight into sky it is because neither of them has a guidance system, or exhaust control. A balloon's erratic movement is the result of resistance that the balloon encounters as it flies through the air. Unlike airplanes and rockets, balloons are not shaped well for fast flight. Further, the material with which a balloon is made is not even and hence when the balloon deflates it may not do so at all points at the same rate. In case of Diwali rockets though there are some controls such as fins, etc., the rate at which the fuel pellet fires or the nozzle through which exhaust comes out are not perfect, resulting in erratic movement. Rockets that are designed to make space flights are carefully designed with aerodynamic controls and stability.

Many different methods have been developed to control rockets in flight. Early rockets typically used movable fins at the rear of the rocket. The movable fin adjusted the amount of the aerodynamic force on the rocket resulting in change in the direction of the flight. Another technique used was to place vent vanes in the nozzle of the rockets to control the direction of the exhaust. Turning these vanes one way or the other deflected a portion of the exhaust gases, pushing the rocket's tail in the opposite direction. Indeed the vanes were a drag on the efficiency of the rocket; whatever amount of downward thrust pushed against the vanes cancelled out an equal amount of the thrust's upward push inside the rocket. To overcome this disadvantage yet have mastery over the flight of the rocket, modern launch vehicles are fitted with 'gimballed' nozzles. A gimbal is a pivoted device that allows the entire nozzle and the flow of exhaust gases, to be swivelled in any desired direction. In a gimballed thrust system, as the exhaust nozzle of the rocket is swivelled from side to side the direction of the thrust is changed relative to the centre of gravity of the rocket. Some rockets use small additional rocket engines at the bottom of the main rocket to generate the control torque. The small control rockets are called vernier rockets. Because of the additional weight for the fuel and plumbing, vernier rockets are not much favoured for control of the rockets during its flight.

Living with Diabetes

The Basic Self-Care Rules

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A healthy body and mind are the greatest treasure a man can have. Yet, once diabetes makes a foray, threats of many kinds loom large. The disease can affect the well being of such vital organs as the eyes, gums, heart and circulatory system, kidneys, and nerves. The risk of such complications as coronary heart disease, high blood pressure, stroke, partial loss of vision, kidney failure, and nerve damage multiply manifold. However, a stitch in time can save nine. A regulated blood sugar and simple self-care can check the damage and accentuate the joy of life.

Go for an annual medical check-up

Beyond the regular follow-up visits to your diabetes doctor, you must undergo a thorough medical check-up once a year. This will facilitate an early diagnosis of any emerging problems that the diabetes may cause. You would be required to take a variety of lab tests, which will reflect the health of the kidneys, heart and circulation. Should these indicate any abnormality or disease, timely action may still limit the damage.

Have a regular eye check-up

Diabetes can affect the eyes severely, and in many possible ways. A fluctuant blood sugar alters the thickness of the natural eye lens, and this can influence the focussing strength of the eye. Diabetes can also cause more serious damage to the eye and trigger the growth of frail new blood vessels in retina. These vessels can leak from time to time and may seriously disrupt vision. Diabetes might also lead to a rise in internal eye pressure, a condition called glaucoma, or spur premature clouding of lens, causing cataract.

A regular check-up with an eye doctor is therefore the best guarantee against such major complications. If these changes can be picked on time, they can be nipped in the bud.

The following eye tests should be done at least once each year:

Visual acuity test: This test measures the sharpness of your vision. The eye doctor or optometrist will check how well you read letters from across the room. Your eyes will be tested one at a time, while the other eye is covered. At the same sitting, you might also be tested on how well you can read the close-up letters by using a specially designed card.

Visual field charting (perimetry): This test assesses how much area you can see in front of you without moving your eyes. In a computerized perimetry test, you look at a testing screen on which a machine flashes spots of light. The flashes will be at different locations on the screen and of varying brightness. Your job is to press a button each time you see a flash. The machine records your responses and maps areas where vision is good.

Retinal examination: During a retinal examination, the eye doctor puts dilating drops in your eyes to open your pupils wide and provide a bigger window to the back of your eye. Then, by using an ophthalmoscope, he can diagnose abnormalities in the vitreous, the retina, the optic nerve and the vascular coat of the eye. This test is especially important because retinal damage is the most common eye complication of diabetes. Treatment with laser can restrict the damage.

Slit-lamp examination: A slit lamp allows the doctor to see the different structures at the front of your eye – cornea, iris and lens and the anterior chamber – in cross section and under magnification. Since diabetes is known to spur early cataract, this examination can pick the changes in the lens early.

Glaucoma test (tonometry): By

measuring the internal pressure of your eye, the eye doctor can determine whether you are developing glaucoma. The disease can gradually narrow your field of vision and produce tube vision and blindness.

Fluorescein angiography: Fluorescein angiography is a special diagnostic test used for evaluating diseases of the retina and the choroid. To carry out the test, fluorescein (a dye) is injected in your arm vein. As it circulates through your eye, the blood vessels in your retina and choroid stand out as bright yellow. A camera takes flash pictures every few seconds for several minutes. This test may not be performed annually, but it can be very useful in assessing the damage to normal eye blood vessels and also view the abnormal blood vessels that might arise in your retina.

Protect against gum disease

High blood sugar can cause infection and inflammation in your gums. You may develop pyorrhoea, a gum disease that can cause bad breath, bleeding from the gums,

and loosen out your teeth. To help prevent damage to your gums and teeth:

- Brush your teeth twice a day.
- Rinse your mouth after each meal.
- See your dentist every six months.
- Look for early signs of gum disease, such as bleeding gums, redness and swelling. If you notice them, see your dentist.

Safeguard your heart and circulatory system

If you have diabetes, you are twice as likely to develop high blood pressure as individuals with normal blood sugar. Your risk of a heart attack, stroke or other circulatory problems is also huge. However, you can fight these odds by monitoring your blood pressure, managing your cholesterol, taking a baby aspirin daily and not smoking.

Monitor your blood pressure: Adults with diabetes must keep their blood pressure below 130/80 points. The same lifestyle changes that can improve your blood sugar – a balanced diet, regular exercise and reduction in weight – can help reduce your blood pressure. Limiting salt (sodium) intake and alcohol is also most useful.

If this does not check your blood pressure, your doctor may prescribe blood pressure-lowering medication. The drugs most commonly used for people with diabetes are angiotensin-converting enzyme (ACE) inhibitors like Lisinopril or Enlapril; and angiotensin II receptor blockers like Losartan. These medications have a low rate of side effects, and they help protect your kidneys and heart, which are at high risk of damage from both diseases. Other high blood pressure medications prescribed to people with diabetes include diuretics, beta-blockers, and calcium channel-blocker drugs.

Tidy up your lipid numbers: People with diabetes often have wonky lipid numbers that contribute to higher rates of coronary heart disease and other circulatory problems. The goal should be to tidy up these numbers: lower your LDL cholesterol to less than 100 mg/dl; triglycerides to less than 150 mg/dl; and raise the HDL cholesterol to more than 40 mg/dl.

Healthful changes in diet, including restriction of saturated fats to less than 10 per cent of the total daily calories, increasing the natural fibre content by taking more of natural foods and less of processed and junk foods, and limiting daily calories is the first prerequisite. Regular exercise can also help bring an improvement. If these measures do not suffice, your doctor may prescribe you a statin such as atorvastatin.

Take an aspirin daily: When you have diabetes, the platelet cells tend to be stickier, and you are at an increased risk of formation of blood clots. Aspirin is an anti-clotting, anti-platelet drug that decreases the stickiness of the platelets, and reduces the risk of a heart attack and stroke.

Unless there is good reason not to take it, you should be taking an aspirin every day. It can reduce your risk of heart attack by up to 60 per cent. The recommended dose is anywhere from 75 mg a day, the amount found in a baby aspirin, to 325 mg a day, the amount in an adult tablet.

You should not, however, take aspirin if you have allergy to aspirin or suffer from peptic ulcer, liver disease or gout.

Do not smoke: If you have diabetes and you smoke, you are three times more likely than non-smokers with diabetes to die of heart disease or stroke, and you are more likely to develop circulation problems in your feet. Therefore, unless you wish to commit hara-kiri, you may as well stop smoking now.

Look after your feet

Diabetes can damage the nerves and reduce blood flow to your feet. Once the nerves are damaged, you lose the protective sensation. You may develop a blister or cut your foot and not realize it. If the blood flow is reduced, the feet receive less blood to nourish the tissues, and it is harder for cuts and sores to heal. It is for this reason that a seemingly small and insignificant injury might easily progress into a serious problem. You can however protect your feet by following these simple rules:

- Wash your feet each day with lukewarm water.
- Wash your feet with a gentle, massage-like motion, using a soft washcloth or sponge and a mild soap. Dry your skin by blotting or patting. Do not rub because you may rub too hard and accidentally damage your skin. Dry carefully between your toes to help prevent fungal infection.
- Moisturize your skin. Diabetes could leave your skin dry. Since dry skin can itch and crack, and can easily get infected, protect against dry skin by using a moisturizer regularly.
- Trim your toenails carefully. Bathe your feet in warm water and clean your toes carefully using a soft toothbrush and mild soap. Then cut the nails straight across so that they are even with the end of your toe. File rough edges. Be especially careful not to injure the surrounding skin. If you notice redness around the nails, report this to your doctor.
- Wear clean, dry socks, preferably cotton-made. Avoid those with tight elastic bands that reduce circulation.
- Protect your feet by wearing shoes, or sturdy slippers. Look inside your shoes for tears or rough edges that might injure your feet. Shake out your shoes before you put them on to make sure nothing is inside, such as a pebble. Always select a comfortable pair of footwear, that isn't narrow, allows air to circulate, is low-heeled, and has a flexible sole.
- If your feet lose sensation be vigilant. Take care that you do not burn them by keeping them too close to a heater during the winter months.
- Do not use a file or scissors on calluses,

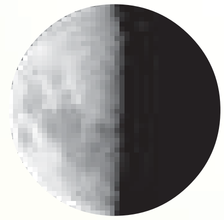
(Contd. on page 20)

Sky Map for July 2007

Full Moon

30 July

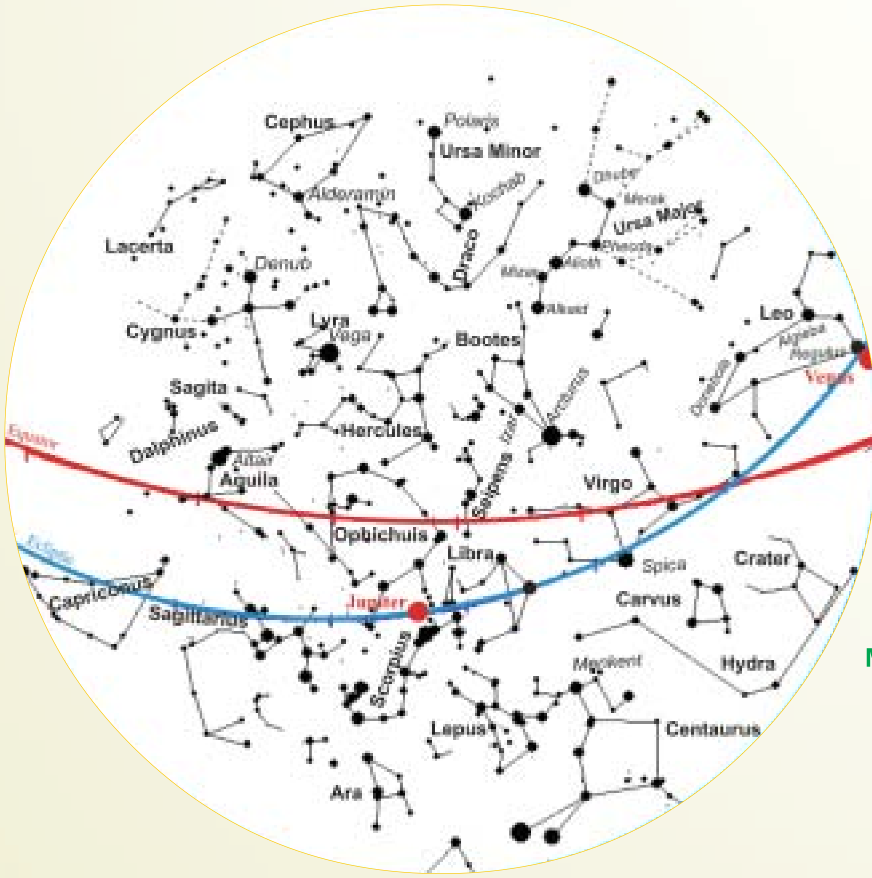
Moon - Last Quarter



7 July

North

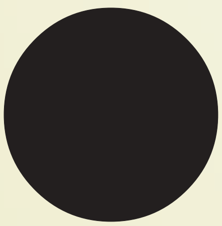
East



West

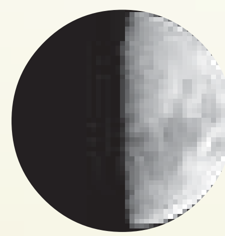
South

New Moon



14 July

Moon - First Quarter



22 July

The sky map is prepared for viewers in Nagpur (21.09^0 N, 79.09^0 E). It includes bright constellations and planets. 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 viewers 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 01 July, at 9:00 PM on 15 July and at 8 PM on 31 July.

Tips for watching the night sky :

(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 constellations as shown in the map one by one.

Planet Round Up:

Venus: In the constellation Leo (Simha *Rashi*), near western horizon.

Jupiter: In the constellation Ophichuis (*Bhujandhari*) up in the zenith.

Prominent Constellations: Given below are prominent constellations with brightest star therein (in the parenthesis). Also given are their Indian names.

Eastern Sky : Aquila (Altair)/*Garuda (Sravan)*, Capricorns *Makar Rash*, Cygnus (Deneb)/ *Hansa*, Delphinus / *Dhanishtha*, Lacerta, Sagita.

Western Sky : Carvus / *Hast*, Crater, Hydra (Alphard)/ Wasuki, Leo (Regulus)/*Simha (Magha)*, Virgo (Spica)/*Kanya (Chitra)*

Southern Sky : Ara, Centaurus (Rigel)/*Narturang*, Lepus / *Shashak*, Sagittarius/*Dhanu Rashi*, Scorpius (Antares)/*Vrischik (Jeshta)*.

Northern Sky : Cepheus /*Vrishaparv*, Draco/*Kaleey*, Ursa Major/*Saptarishi*, Ursa Minor (Polaris)/ Dhurva Matsya/Dhurva Tara,

Zenith : Bootes (Arcturus)/*Bhutaap (Swati)*, Hercules/*Shauri*, Libra/ *Tula Rashi*, Lyra (Vega)/*Swaramandal (Abhijeet)*, Ophiuchus/ *Bhujangdhari*

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Earthquake Tip-13

Why should Masonry Buildings have Simple Structural Configuration?

Box Action in Masonry Buildings

Brick masonry buildings have large mass and hence attract large horizontal forces during earthquake shaking. They develop numerous cracks under both compressive and tensile forces caused by earthquake shaking. The focus of 'earthquake resistant' masonry building construction is to ensure that these effects are sustained without major damage or collapse. Appropriate choice of structural configuration can help achieve this.

The structural configuration of masonry buildings includes aspects like (a) overall shape and size of the building, and (b) distribution of mass and (horizontal) lateral load resisting elements across the building. Large, tall, long and unsymmetrical buildings perform poorly during earthquakes (*IITK-BMTPC Earthquake Tip 6)*. A strategy used in making them earthquake-resistant is developing good 'box action' between all the elements of the building, *i.e.*, between roof, walls and foundation (Figure 1). Loosely connected roof or unduly slender walls are threats to good seismic behaviour. For example, a horizontal band introduced at the lintel level ties the walls together and helps to make them behave as a single unit.

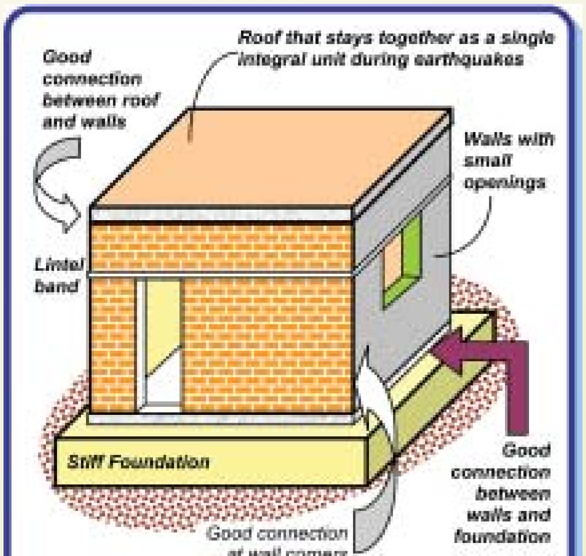

Figure 1: Essential requirements to ensure box action in a masonry building.

Influence of Openings

Openings are functional necessities in buildings. However, location and size of openings in walls assume significance in deciding the performance of masonry buildings in earthquakes. To understand this, consider a four-wall system of a single storey masonry building (Figure 2). During earthquake shaking, inertia forces act in the strong direction of some walls and in the weak direction of others (See *IITK-BMTPC Earthquake Tip 12*). Walls shaken in the weak direction seek support from the other walls, *i.e.*, walls B1 and B2 seek support from walls A1 and A2 for shaking in the direction shown in Figure 2. To be more specific, wall B1 pulls at walls A1 and A2, while wall B2 pushes against them. At the next instance, the direction of shaking could change to the horizontal direction perpendicular to that shown in Figure 2. Then, walls A and B change their roles; Walls B1 and B2 become the strong ones and A1 and A2 weak.

Thus, walls transfer loads to each other at their junctions (and through the lintel bands and roof). Hence, the masonry courses from the walls meeting at corners must have good interlocking. For this reason, openings near the wall corners are detrimental to good seismic performance. Openings too close to wall corners hamper the flow of forces from one wall to another (Figure 3). Further, large openings weaken walls from carrying the inertia forces in their own plane. Thus, it is best to keep all openings as small as possible and as far away from the corners as possible.

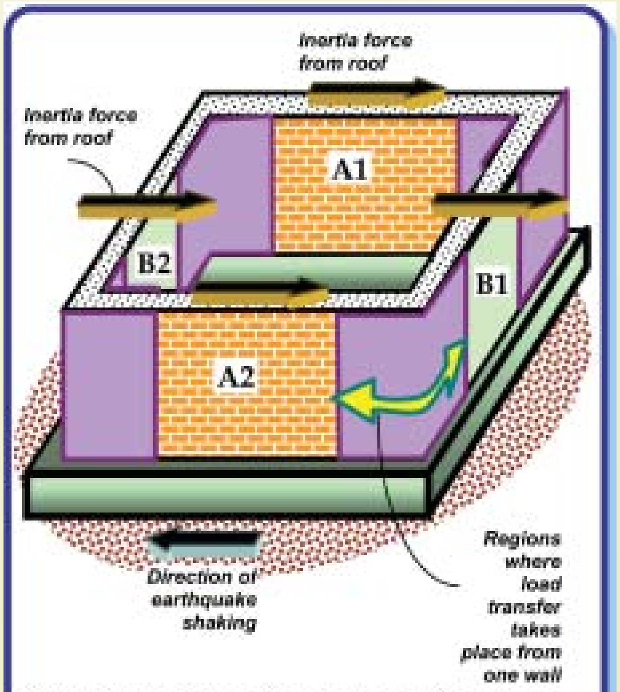

Figure 2: Regions of force transfer from weak walls to strong walls in a masonry building – wall B1 pulls walls A1 and A2, while wall B2 pushes walls A1 and A2.

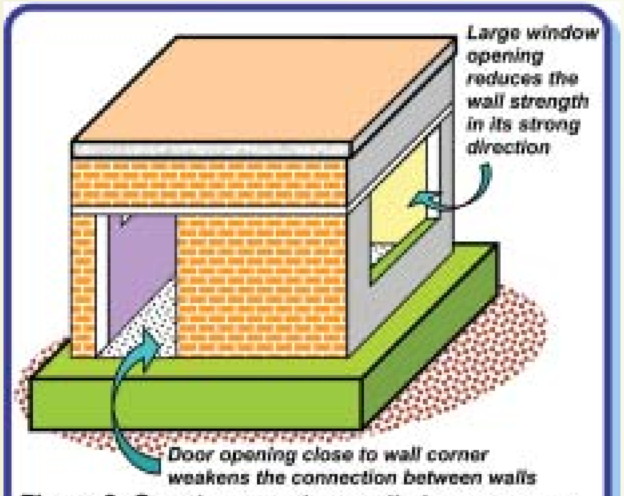

Figure 3: Openings weaken walls in a masonry building – *a single closed horizontal band must be provided above all of them.*

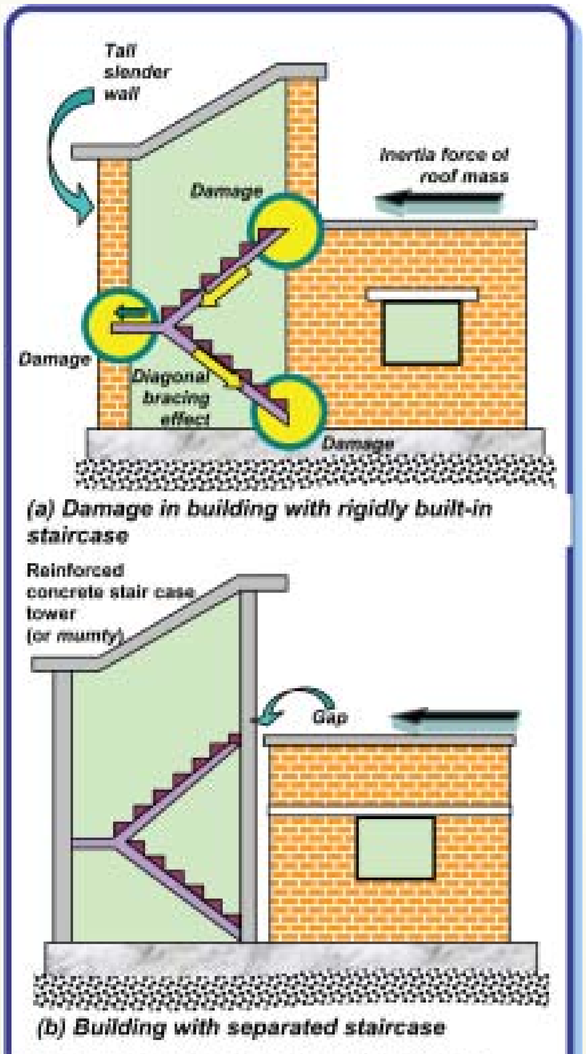

Figure 4: Earthquake-resistant detailing of staircase in masonry building – *must be carefully designed and constructed.*

Earthquake-Resistant Features

Indian Standards suggest a number of earthquake-resistant measures to develop good 'box-type' action in masonry buildings and improve their seismic performance. For instance, it is suggested that a building having horizontal projections when seen from the top, *e.g.*, like a building with plan shapes L, T, E and Y, be separated into (almost) simple rectangular blocks in plan, each of which has simple and good earthquake behaviour (*IITK-BMTPC Earthquake Tip 6*). During earthquakes, separated blocks can oscillate independently and even hammer each other if they are too close. Thus, adequate gap is necessary between these different blocks of the building. The Indian Standards suggest minimum seismic separations between blocks of buildings. However, it may not be necessary to provide such separations between blocks, if horizontal projections in buildings are small, say up to ~15-20% of the length of building in that direction.

Inclined staircase slabs in masonry buildings offer another concern. An integrally connected staircase slab acts like a cross-brace between floors and transfers large horizontal forces at the roof and lower levels (Figure 4a). These are areas of potential damage in masonry buildings, if not accounted for in staircase design and construction. To overcome this, sometimes, staircases are completely separated (Figure 4b) and built on a separate reinforced concrete structure. Adequate gap is provided between the staircase tower and the masonry building to ensure that they do not pound each other during strong earthquake shaking.

Resource Material

1. IS 1905, (1987), *Indian Standard Code of Practice for Structural Use of Unreinforced Masonry*, Bureau of Indian Standards, New Delhi.
2. IS 42326, (1993), *Indian Standard Code of Practice for Earthquake Resistant Design and Construction of Buildings*, Bureau of Indian Standards, New Delhi.
3. IS 13828, (1993), *Indian Standard Guidelines for Improving Earthquake Resistance of Low-strength Masonry Buildings*, Bureau of Indian Standards, New Delhi.
4. Tomazevic,M., (1999), Earthquake Resistant Design of Masonry Buildings, Imperial College Press, London, UK.

Related IITK-BMTPC Related Earthquake Tip

Tip 5 : *What are the seismic effects on structures?*
Tip 6 : How architectural features affect buildings during earthquakes?
Tip12 : How brick masonry houses behave during earthquakes?

Acknowledgement :
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Recent Developments in Science and Technology

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Titan's organic factory

Till 1980 Saturn's largest moon Titan was considered the largest among the moons of Solar System planets. But when its thick atmosphere was discovered during *Voyager* flyby it was realised that Titan was not really as large as it appeared from Earth. Its dense atmosphere, which appears as smog-like haze surrounding the moon, is what makes it appear larger than actual. The most puzzling feature of Titan's haze has been its composition. What was it made up of? Astronomers had long suspected that the haze is made up of complex organic molecules – may be even some life-forming ones. But there was no concrete evidence. Then in late 2004, the *Cassini* orbiter began a series of close encounters with Titan, taking data with many instruments. And in January 2005, the *Huygens* probe actually landed on the surface of Titan and sent back images from the surface. The recent close flybys of Titan by the *Cassini* spacecraft for the first time provided concrete evidence of complex organic molecules actually forming on Titan. The existence of benzene, along with both positively and negatively charged organic ions has been reported in a recent issue of *Science* (11 May 2007).

Titan's atmosphere

Compared to other moons of the solar system, Titan is unique because of its massive atmosphere, which consists of 95% nitrogen and 5% methane. Solar radiation and charge particles from Saturn's active magnetosphere are believed to initiate chemical reactions that lead to the formation of more complex organic molecules. Simple hydrocarbons such as ethane, acetylene, and diacetylene, and nitriles such as hydrogen cyanide and cyanogen form readily, while more complex molecules such as propane, butane, polyacetylenes, and cyanoacetylene are created from these simpler molecules. The presence of benzene was detected for the first time by the Infrared Space Observatory in 2003. Benzene is the starting point of other more complex molecules, such as polycyclic aromatic hydrocarbons in Titan's atmosphere.

Interestingly, although substantial quantities of benzene and cyanogen have been detected by *Cassini* spacecraft in the outer layers of Titan's atmosphere, the *Huygens* probe, which descended through the moon's dense atmosphere, detected much lower concentrations, most likely due to the low abundance of these complex molecules in the atmosphere below 146 km where the data were taken.

Apes walked on two legs before humans

Anthropologists had always believed that walking upright was a typical human trait. In fact, walking on two legs, or bipedalism, was considered the turning point in the evolution of *Homo sapiens*, the human species. Humans' closest relatives, chimpanzees and gorillas, walk on all fours, and fossils provide strong evidence that our ancestors did the same. It was believed that bipedalism was a trait acquired once early ancestors of modern humans left their abode on forest trees and started living on ground, as vast areas of African forests disappeared about five million years ago due sudden changes in Earth's climate. But a study of orang-utans walking through the treetops suggests that walking upright may have come about long before it was believed earlier and may have been present in ancestors of modern humans when they were still tree-dwelling animals. These apes may also have been the first to stand upright in the trees, according to a paper published in the journal *Science* (1 June 2007).

The finding is based on nearly 3,000 observations of wild orang-utans moving through the forests of Sumatra by Susannah Thorpe and Roger Holder of the University of Birmingham, and Robin Crompton of the University of Liverpool, UK, and his colleagues. Orang-utans spend more of their time in the trees than any other great ape. The researchers found that the animals walked upright especially when going over slender, flexible branches, holding on to upper branches with their hands to steady themselves. This kind of 'hand-assisted bipedal movements' gave the animals an advantage over others. "There is a lot of pressure on fruit-eaters to go to the periphery of trees where branches are smallest, because that's where the fruits actually are," says the researchers. Another advantage is being able to reach out with a free hand to the branches of an adjacent tree, and cross to it without the effort of descending. The researchers believe that a similar behaviour is the most plausible precursor of true bipedal walking. In fact, the new findings suggest that walking on two legs may have actually preceded living on ground, and that some of early ape ancestors of modern humans may have already been walking on two legs, 17 to 25 million years ago, long before the African forests disappeared and they came to living on ground.

Geneticists identify new breast-cancer genes

A team of scientists at the University of Cambridge, England, led by Douglas Eaton have developed a new technique to identify genes that increase the chance of women developing breast cancer (*Nature* online, 27 May 2007). It used to take decades to go through a patient's DNA and find faulty genes, but the newly-developed technique now makes the process much faster. The computer-based process can be completed in just a few hours and scientists believe that, within a few months, researchers could find all the genes involved in the development of breast cancer. To find the four new genes, the researchers sifted through the DNA of nearly 50,000 women, half of them breast cancer patients and half healthy. The discoverers of the new technique hope it will lead to a single blood test, which would reveal a woman's risk of getting the disease.

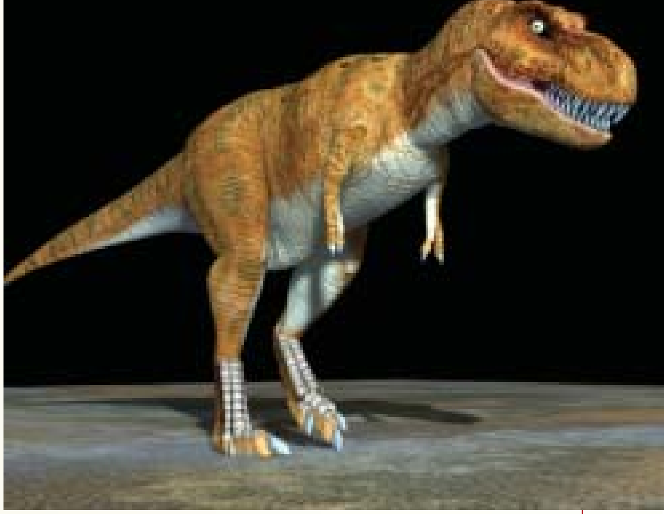
Two of the genes identified, FGFR2 and TNRC9, are thought to increase the risk of breast cancer by about 20% in women who carry one faulty copy of a gene and by between 40% and 60% in those who carry two faulty copies. The lifetime risk for women with two faulty copies in either of these two genes would rise from one in 11 to around one in six or seven. The other two genes increase risk by 10% if there is one fault.

A maximum 10% of breast cancers have a genetic element, and the genes scientists know about so far account for 25% of these. The newly identified genes account for a further 4% and are responsible for only a small number of breast cancers – only about 0.4% of the cases diagnosed every year.

Breast cancer is twice as common in those who have a close relative who develops it due to a fault in a gene, although the presence of a faulty gene does not mean that cancer will definitely occur. At present, scanning these newly discovered genes would tell a doctor little about a woman's cancer risk. But as more and more genetic risk factors are uncovered, genetic profiling could give doctors a fine-grained picture of individual risk, and could even lead to custom-designed treatments offering the best chance of preventing or treating the disease.

Proteins recovered from *T. rex* fossil

Fossils are the remains (or an impression) of a plant or animal that existed in a past geological age and that has been excavated from the soil. It has been always believed that in the process of fossilisation most of the original organic components are destroyed. What remains are only the hard parts converted into siliceous material. The cloning of dinosaurs in the blockbuster movie Jurassic Park could have been mere fiction, but according to a recent report, American researchers Mary H. Schweitzer of North Carolina State University, and her colleagues have indeed succeeded in extracting collagen



T. rex

protein from a 68-million-year-old *Tyrannosaurus rex* femur, which two years ago was revealed to have soft tissue (*Science* 13 April 2007). The skull, vertebrae, femurs, and elements of an exceptionally well-preserved specimen of *T. rex* were recovered from a site in eastern Montana (USA). The findings were independently confirmed by mass spectrometry. Chemical analysis of the protein yielded seven sequences of about 10 to 20 amino acids in length. Three sequences matched collagen peptide sequences from chickens, one matched a frog and another a salamander. Although no genetic material was recovered, as they would have degraded long ago, the results do strengthen the bird-dinosaur connection and rule out the belief that ancient fossils could not provide protein samples for study. The methods used to extract and identify the proteins could be of great help in clarifying the relations between extinct species and modern-day animals.

Living with Diabetes *(Contd. from page 25)*

corns or bunions. You can injure your feet that way. Also, do not put chemicals on your feet, such as wart remover plasters. Instead, see your doctor.

- Check your feet every day. Look for blisters, cuts, bruises, cracks, peeling, redness, and swelling.
- Do not delay treatment. If a wound isn't healing, appears to be getting bigger or looks as if it may be infected, see your doctor.

Skin care

- Maintain good hygiene. Take a shower every day. Use a mild soap, and clean yourself.
- Dry your skin by blotting or patting with a soft towel. Do not leave any wet areas, because that can encourage fungal growth.
- Apply talcum powder on such areas of the body that sweat more, like the armpits, inner folds of upper thighs, and the area below the breasts.
- Never wear underpants that are tight around the thighs. Also, avoid tights, skin-hugging jeans and nylons. Instead, prefer loose-fit cottons.

Travel safety

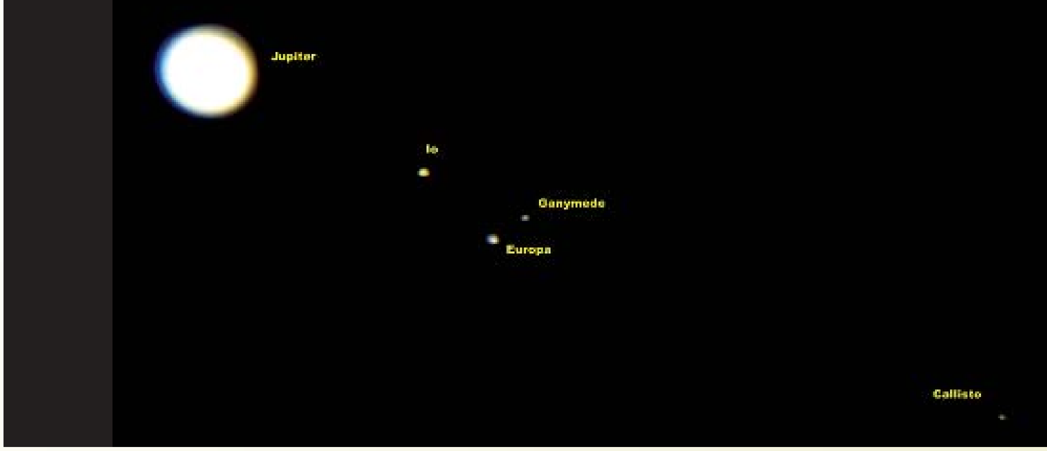
- Prepare well. Carry medical identification with you and bring enough diabetes supplies and medications to last the entire trip – plus a little extra in case of scheduling changes. Do not put these items in checked bags. Keep them in your carry-on bag.
- Take along food such as biscuits, glucose or candies to treat low blood sugar or in case you do not eat on schedule.
- Never take a pair of new shoes with you. Try them out on the home terrain, before using them for travel. It is also a good idea to pack two pairs of good walking shoes.
- As much as possible, try to follow your daily walking and eating regimen.
- Find out how to say in the native tongue, 'I am a diabetic. I need to see a doctor'. This can save the day in a moment of crisis.

VP News

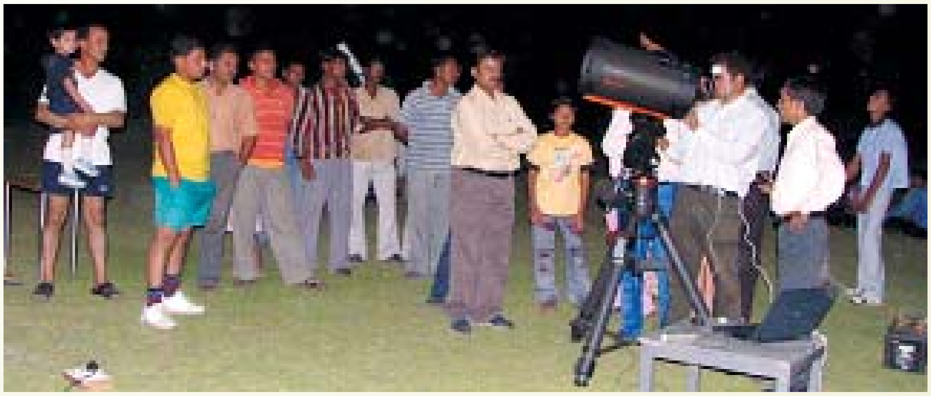
Planet Marathon on 02 June 2007

Night of 2 June 2007 was a special night for astronomy enthusiasts because that night one could see all the seven planets of our solar system. To take advantage of the occasion Vigyan Prasar organised a night sky watching and planet-viewing programme at Apollo International School, Sonipat (Haryana).

Vigyan Prasar team consisting Arvind C Ranade, R K Yadav, Vikram Guleliya, Navneet Tyagi, and Manbeer Singh conducted the programme. The principal of the school Shri Raghunath Mukharji along with a team of teachers mobilized the students and members of the public to come and watch the rare celestial event. VP's *Celestron CGE* 11-inch and 80-mm Newtonian reflector telescopes were used to show the planets and the Moon to the gathered audience. Nearly 200 people witnessed the event. The crescent phase of Mercury was visible around 8:15 PM. Venus in quarter phase and Saturn with beautiful rings were also shown to the public. In the early morning of 3 June between 3 and 4 AM Uranus, Neptune and Mars were also visible in the sky. The electronic media channel IBN-7 covered the event in their bulletin.



Jupiter and four Galilean moons taken with VP's Celestron CGE *11-inch telescope (edited by R K Yadav)*



Arvind C Ranade, Scientist, VP, while setting up the Celestron *11-inch telescope.*

Sensitisation-cum-demonstration workshop on Innovative Physics Experiments for VIPNET members of Orissa

Vigyan Prasar organised a three-day sensitisation-cum-demonstration workshop on Innovative Physics Experiments for the VIPNET members and select teachers of Orissa. The programme was jointly organised at Bhubaneswar from 17 to 19 May 2007 with Indian Institute of Youth and Development (IIYD) Kalinga, Orissa. The workshop was inaugurated by Prof Basudev Kar, President, Orissa Science Academy. Shri D. C. Mishra, IAS, Director, Secondary Education, Govt of Orissa, Shri B.P.Mishra, Regional Manager, Water Aid India, Bhubaneswar, Shri B.K.Tyagi, PSO, Vigyan Prasar, Shri P.C.Mishra, IIYD, Dr. Nikhil Patnayak, Sujanika, and Shri Kapil Tripathi, Vigyan Prasar were also present and addressed the teachers and VIPNET members.

Around 60 teachers, and representatives of various VIPNET clubs and NGOs from various districts of Orissa participated in the workshop. The first day was exclusively devoted for the orientation of the member to take up some special science popularisation activities during the Year of Planet Earth-2008. Smt. Puspshri Patanik of Surjanika gave demonstration of a number of activities that could be taken up by the clubs.

Next two days were exclusively devoted for the innovative physics experiments. Dr. Mukesh Roy of IITM, Jabalpur and Smt. Susmita were the main resource persons for this activity. More than 120 experiments were demonstrated and performed by the resource persons. A documentary on Albert Einstein "The Magical Year" was also screened along with the demonstration of various kits developed by Vigyan Prasar.

Letters to the Editor

I have been regular reader of your magazine *Dream 2047* since its inception. I really appreciate the efforts being put in by your group in bringing out a valuable document like this which can be easily understood even by a layman. I congratulate your team in this context. I am in close touch with many magazines of different countries relating to a similar cause but I can proudly say yours is the best. The topics cover a wide spectrum of science ranging from simple to complex topics. I once again congratulate for this excellent job. All the best wishes.

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