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Monthly Newsletter of Vigyan Prasar

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VP News

Edusat Interactive Terminal Network : Orientation Programme

Vigyan Prasar (VP) has taken an initiative to establish a satellite interactive terminal (SIT) network specifically for Science and Technology (S&T) communication using Edusat – the satellite for Education, Science and Technology - launched by ISRO in 2004. In the first phase, VP is in the process of setting up 20 SITs in different parts of the country. A teaching end terminal has already been set up at VP for transmission of interactive programmes to these terminals. This is a joint initiative of VP and Development and Educational Communication Unit (DECU) / ISRO.

The field centres where the SITs have been / are being set up – also called the classroom ends - were identified by the State Councils/ Departments of Science and Technology in various States. Till date 13 terminals have already been set up. It may take some more time for the remaining terminals to be set up – mostly in the North-East. It is estimated that the work would be completed by end of Feb 2006. Using EduSat, the members of the network – the classroom ends - would be able to interact in the two way video – two way audio mode with the teaching end at VP. Incidentally, this is for the first time that an interactive mode is used exclusively for S&T communication using a satellite. Transmission has already begun on a trial basis. Regular programming is proposed to commence from February 2006.

A section of the participants

With a view to provide orientation to the field coordinators, a two-day orientation programme was organized by VP on 27-28 December 2005 at Central Institute of Educational Technology (CIET), NCERT, New Delhi. The programme was inaugurated on 27 December 2005 with a technical session wherein Dr VB Kamble, Director, VP elucidated the potential of EduSat network for science communication. Shri G. P. Singh, Engineer, Delhi Earth Station (DES) / ISRO made a presentation on the technical aspects of Edusat. Shri Haraniya, Manager, M/S Infinium - the agency supplying the SITs - elucidated the operational aspects of the EduSat communication system as well as the SIT. Shri Gajendra Singh, Engineer, DES, made a presentation on the classroom end of EduSat Network.

On 28 December 2005, the second day of the workshop, the participants visited the VP teaching end located at the

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Inside

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

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Editor : Dr. V.B. Kamble

Tsunami – A Year After

Indian Ocean Tsunami of 26 December 2004 was probably the worst ever natural disaster in the living memory. Surely, natural disasters are not uncommon in this part of the world. But, a disaster of this nature and magnitude was unheard of. Some three lakh people perished by the time the killer waves receded. Tsunami travels with speeds of about 500 to 1000 kilometres per hour in the deep ocean. As a result, the first wave reached within three hours from Sumatra and the Andaman Islands to reach Myanmar, Thailand and Malayasia in the east; and to Sri Lanka, India and Maldives in the west. Within 11 hours, it had travelled 8000 kilometres and struck South African coast – where a tsunami related death was reported. The waves did not stop there. On its westward path, tsunami curved around the southern tip of Africa and then split into two branches – one heading toward Brazil and the other toward Nova Scotia in eastern coast of Canada. On its eastward path, it travelled through the gap between Australia and Antarctica into the Pacific as far as the western coast of Canada! It was truly a global phenomenon. Earlier, it was only on 27 August 1883 that a tsunami generated by the eruption of Krakatau volcano that had travelled so far. This too was in Indian Ocean that claimed 36,000 lives in the Indonesian islands of Java and Sumatra.

The December 2004 tsunami took the largest toll than any tsunami ever recorded, but it was also the one best documented in history – opening a unique opportunity to learn how to avoid such catastrophes in future. We had the videos of giant waves devouring the sea-side hotels, and at the same time we had satellite measurements of the waves propagating across the open ocean. All this information has reshaped in several ways about what we know of the origin of tsunamis and their forecast, say Eric L. Geist, Vasily V. Titov and Costas E. Synolakis, in a recent article in *Scientific American*.

The location from where the 2004 tsunami originated was considered unlikely to give birth to giant waves. Indeed, tsunami-generating earthquakes occur at a region where two tectonic plates meet head on - also called fault, with one plate thrusting over the other displacing huge quantity of water and raising tsunami waves along with it. The magnitude 9.3 earthquake that triggered the tsunami on 26 December 2004 was truly complex. The fault slip is largest at the start, near its origin. In some cases, however, the fault break begins with a small amount of slip – one would then expect a small earthquake. But, then it hits a weak or highly stressed part of the fault that lets loose violently. This may result in a much higher earthquake and tsunami. This is what happened in 2004. Later analysis revealed that this massive shock raised a 1200 kilometre stretch of seafloor by as much as eight metres in some places displacing hundreds of cubic kilometers of sea water above normal sea level! No wonder, events like this are difficult to analyze in time to make a useful warning.

It may be of interest to note that entire Pacific Rim is tsunamigenic - this is why it is also called the “Ring of fire”. But in the Indian Ocean, tsunami-generating earthquakes are known to occur only in two regions – in the east where a fault runs from Myanmar to Sumatra encompassing Andaman and Nicobar islands and in the west in the Makran fault in Pakistan. However, the part of the Sumatra-Andaman fault where the disaster originated, had no previous record of shocks larger than magnitude 8. When a magnitude 9.3 earthquake struck there in December 2004, followed three months later on 28 March 2005 by another nearly as large as magnitude 8.7, scientists began reassessing similar slow moving faults for their tsunami potential. It was fortunate that the 28 March earthquake occurred underneath shallow water, so it raised a smaller amount of water. Further, it struck about 100 kilometres farther south. Hence, most of its eastbound waves hit Sumatra thereby shielding Thailand and Malaysia. The westbound waves headed out to sea. On the earlier occasion, both eastbound and westbound waves struck the landmasses.

From the new data, scientists have now learned how to better forecast what areas could give rise to a tsunami, where it will go and how far it will climb up on shore. This event has also revealed that complexities associated with an earthquake could be quite subtle and that they may have a remarkably strong influence over tsunami’s size and shape. Observations of the December 2004 tsunami confirmed our basic understanding of three key aspects of tsunami behaviour – how large events propagate around the world, what the waves look like in the open ocean and how far inland the waves will climb. The hopes are high that the improved models of the tsunami phenomenon that have resulted from these discoveries will work with new monitoring and warning systems to help save lives.

The Indian Ocean had no tsunami warning system before December 2004. However, since then, several international groups, coordinated by UNESCO’s Intergovernmental Oceanographic Commission, have begun the task of setting up of an early warning system in the Indian Ocean by 2008

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Science Breakthroughs of the Year 2005

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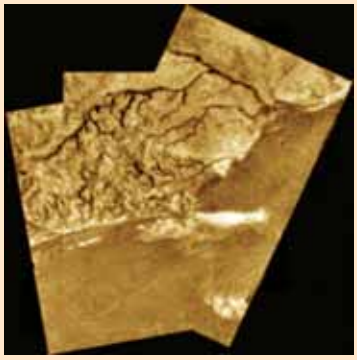
The year 2005 will go down in history as the year when humankind established its presence farthest away from its home planet. It was also a year when the tenth planet of our solar system was discovered; the complete genetic make-up of our closest kin in the animal world deciphered; new evidence of our still-evolving brain found; the largest invertebrate in the world photographed live, in its natural, deep-sea environment; and much more happened in science.

Titan Unveiled

The biggest science news of year undoubtedly was the landing of the space probe *Huygens* on Titan – the largest moon of Saturn. After a seven-and-a-half-year interplanetary journey aboard NASA's *Cassini* spacecraft, the European Space Agency's *Huygens* probe finally drifted down on to Saturn's haze-shrouded moon Titan on 14 January 2005, the furthest from Earth that a spacecraft had ever touched down. The information gathered as *Huygens* parachuted through the atmosphere and finally settled on the moon's surface is shedding light on a world that may look a lot like Earth did 4,600 million years ago. The probe found evidence of methane rain, erosion, drainage channels, dry lakebeds, volcanism and very few craters. *Huygens* found liquid methane on surface of Titan as opposed to water on Earth. Rocks on Titan were found to be made up of dirty ice as opposed to silicate rocks found on Earth.

Titans surface



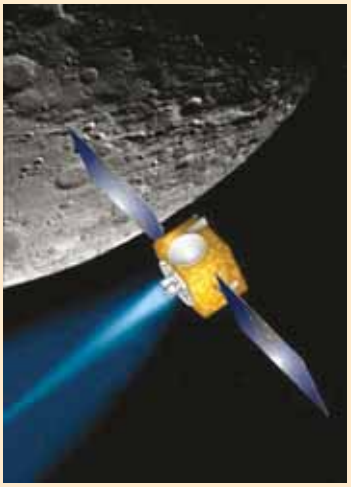
Titans frozen coastline

Data sent back by *Huygens* show that gases like argon are not present on Titan; oxygen is tied up in frozen water preventing formation of carbon dioxide. In Titan's upper atmosphere nitrogen is the dominant gas and in lower atmosphere methane is present in higher abundances. Methane levels on the surface changes over time implying a release of methane. The origin is probably liquid methane located just below the surface.

The *Cassini* spacecraft in the mean time toured Saturn's moons and sent back breathtaking photographs of the icy satellites. Planetary scientists will take years to analyse the images and other data sent back by the two probes.

SMART-1

During the year another first in space was achieved. *SMART-1*, the first spacecraft using a solar-electric propulsion system (ion engine) arrived at the Moon on an exploratory mission. *SMART-1* is the first of European Space Agency's 'Small Missions for Advanced Research in Technology'. It will make the first comprehensive inventory of key chemical elements in the lunar surface. It will also investigate the theory that the Moon was formed following the violent collision of a smaller planet with Earth, 4,500 million years ago.



SMART 1

A Tenth Planet?

A noteworthy astronomical discovery announced during the year was that of a planet-like object larger than Pluto in the far reaches of our solar system. Roughly three times farther away than Pluto, the new object, which has been named Sedna and which may turn out to be the tenth planet of our solar system, is the most distant known object in the solar system and the third brightest member of the Kuiper Belt. Near-infrared spectra show signs of methane ice on the surface of the new object, indicating that it has not been warmed significantly since the birth of the solar system some 4.5 billion years ago.

Although the announcement of the discovery was made on 29 July 2005 by Michael Brown, a planetary scientist at the California Institute of Technology in USA, the new planet was first spotted by Brown in October 2003 with the Samuel Oschin Telescope at Palomar Observatory near San Diego, California, along with his colleagues Chad Trujillo at the Gemini Observatory on Mauna Kea, Hawaii, and Yale University's David Rabinowitz. Currently known by the catalogue number 2003UB313, the newly discovered planet-like object is 2,683 kilometres in diameter (compared to Pluto's 2,360 km) and orbits the Sun in a highly elliptical

orbit. Unlike most planetary orbits, which lie more or less in the ecliptic plane, 2003UB313 goes round the Sun in an orbit tilted almost 45° out of this plane, and takes pretty long – 560 years – to complete one trip around the Sun. At its most distant, the object is 97 times farther from the Sun than Earth. At its closest, it passes inside the orbit of Pluto at a distance of some 36 astronomical units.

Although 2003UB313 is being publicized as the tenth planet of the solar system, its status as a planet has not

Sedna

yet been cleared by the International Astronomical Union (IAU). While Pluto, which is smaller than 2003UB313, has been accepted as a planet since it was discovered in 1930, questions are now being raised as to its eligibility to be called a planet. Many astronomers feel it is too small to be called a planet. The recent discoveries will once again ignite the debate about the qualifications of an object to be called a planet, an issue the IAU is wrestling with as the official naming organisation for this area of science.

Mystery of Gamma-ray Bursts Solved

During the year, a 35-year-old astronomical mystery of the origin of powerful, split-second flashes of light called short gamma-ray bursts (GRBs) was solved. The flashes are brighter than a billion Suns, yet last only a few milliseconds. Short GRBs (those lasting less than 2 seconds) flash in every direction of the sky. Till now, astronomers could only theorize about their cause, since the bursts notoriously expire almost as quickly as they shine. They had been too fast for earlier instruments to catch.

The success came through coordination of observations from several ground-based telescopes and NASA's *Swift* and other satellites. The first breakthrough came as NASA's *Swift* Observatory recorded a short burst on 9 May 2005 lasting just 0.03 second. The space telescope swivelled around and imaged a weak, fast-fading X-ray afterglow – the first ever captured from a short GRB source. By targeting the event's location, *Swift* took a crucial first step toward discovering the mechanism causing these types of events.

Now astronomers know that the short gamma-ray bursts are produced by either the collision of two small but dense stars, known as neutron stars, or the collision of a neutron star with a black hole. The finding finally confirms a theory called the 'merger model' and opens the door not only to more detailed studies of these unusual events but also has the potential for detecting gravitational waves – the elusive oscillations in space-time created by gravity. From the data gathered, astronomers now estimate that for every short gamma burst that is detected, another 30 go undetected. That knowledge could advance studies being conducted using gravitational wave detectors, which are being used to measure gravitational waves from sources such as black holes, which evade understanding in part because they do not emit radiation.

Source of Dark Matter Identified

The year also saw a probable answer to one of the biggest riddles of cosmology – the existence of dark matter. Cosmological theories based on the observable universe predicts that dark matter and dark energy may make up as much as 90 percent of the universe, and that ordinary matter, or baryons – the subatomic particles that form planets, stars and the like – account for the remainder 10 percent. The baryons computed by other means bring this total to only about 50 percent; that is, dark matter still makes up 50 per cent of our universe. Dark matter is not readily visible because it neither emits nor reflects electromagnetic radiation, such as light or radio signals. If discovered its existence could explain gravitational anomalies seen in the motion and distribution of galaxies.

Swift spacecraft

New findings reported in the British journal Nature during the year identify the probable source of this missing matter. Previous work had suggested that baryons might be inhabiting extremely hot intergalactic gas, but researchers did not know enough about the density of the baryons to draw firm conclusions about their number. In a new study, Fabrizio Nicastro of the Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts, USA, and his colleagues obtained high-quality spectra of hot intergalactic gas while it was illuminated by the flaring of a quasar-like galaxy named Markarian 421. Based on those spectra, the team

Markarian 421galaxy

determined that the density of the baryons in the gas was sufficient to account for the missing matter. Data from the *Chandra X-ray Observatory*, it appears, indicate that the lost baryons may be swimming in diffuse rivers of gas in the intergalactic medium too hot to see with an optical telescope.

A Deep Cometary Impact

On 4 July 2005, NASA astronomers created the first human-made firework in space when they guided a 372-kilogram coffee table-size projectile released by the spacecraft *Deep Impact* to collide head-on with the nucleus of Comet Tempel-1. The collision took place at more than 37,000 kilometres per hour, generating the explosive force of nearly 5 tonnes of TNT. The impactor's camera relayed a steady stream of detail-rich images until just seconds before its demise. By studying the size and shape of the crater formed by the impact (estimated to be 100 metres across), and the composition and motion of the stuff that flew away from the impact, the *Deep Impact* scientists hope to learn how comets are put together.

Data from the mission are still being analysed, but initial results were surprising. The material excavated by the impact contained more dust and less ice than had been expected. In addition, the material was finer than expected; scientists likened it to talcum powder rather than sand. One disappointment was that the impact does not seem to have penetrated below the upper layer of material in the comet; according to some scientists, it only "scratched the surface".

Global Fusion Reactor

In a significant development in international cooperation in science, the year 2005 saw the finalisation of a site to locate the International Thermonuclear Experimental Reactor (ITER) to tame nuclear fusion for humanity. Sponsored jointly by seven member nations – China, the European Union (EU), Japan, South Korea, Russia, the United States, and India – the $12 billion reactor will be located at Cadarache in southern France. The basic concept behind ITER – using superconducting electromagnets to hold plasma of hydrogen isotopes at a temperature and pressure high enough to achieve nuclear fusion – was born in the 1980s, but the design effort, shared among centres in Europe, Japan, and the United States, didn't always go smoothly. When completed, ITER will be the second largest science project in history after the International Space Station. After decades of experimentation at national and regional level, it should demonstrate once and for all whether it is possible to harness the tremendous potential of nuclear fusion in a practical and economic way.

ITER reactor

As a partner in the project, India would be expected to pick up about 10 per cent of the costs and may have to invest some Rs.250 crores a year for the next ten years or so for the project. India's contribution would include Indian scientists and engineers working on the design, installation and operation of the ITER and Indian industry having an opportunity to supply components and equipment for the ITER project. With its experience of supplying a wide range of components and equipment for the country's diversified nuclear industry, Indian industry is well poised to secure some of the contracts for ITER.

Chimp Genome Sequenced

One of the most exciting developments in life sciences during the year was the sequencing of the genome of humankind's closest living relative, the chimpanzee by the Chimpanzee Sequencing and Analysis Consortium, made up of 67 scientists from around the world. The publication of a draft sequence of this primate's genome, which contains some three billion base pairs, provided the most detailed look yet at the similarities, and differences, between humans and chimpanzees. The researchers studied the DNA of a male chimpanzee named Clint that lived at the Yerkes

National Primate Research Center in Atlanta, Georgia, USA, until he passed away at the age of 24.

The genome data confirm our close kinship with chimpanzees and shows that we differ by only about 1 per cent in the nucleotide bases that can be aligned between our two species, and the average protein differs by less than two amino acids. But the data also show that a surprisingly large chunk of non-coding material is either inserted or deleted in the chimp as compared to the human, bringing the total difference in DNA between our two species to about 4 per cent.

Humans are believed to have diverged from chimps between roughly six million and seven million years ago. By studying the chimp genome, scientists hope to better understand our own biology and what sets humans apart.

Explorations of the Brain

Remarkable progress in brain research was reported during the year. Two papers published in the British journal *Nature Neuroscience* gave a glimpse of the breakthroughs that may one day make it possible for scientists to "read" minds. One study reported in the journal involved using magnetic resonance imaging (MRI) scans of people's brains to reveal what types of images they have recently seen. The researchers, Yukiyasu Kamitani of ATR Computational Neuroscience Laboratories in Kyoto, Japan, and Frank Tong of Princeton University, showed subjects one of eight visual stimuli – images with stripes aligned in various orientations. They found that there were slight differences between the MRI data collected while the volunteers were gazing at the images depending on what picture they viewed. Using a computer program that recognized the patterns the researchers found that they could successfully predict what images the subjects saw. What is more, when a volunteer was shown two sets of stripes simultaneously – but told to pay attention to just one – the team could tell from the MRI scans which set the subject was concentrating on.

Clint the chimp

In the second study, John-Dylan Haynes and Geraint Rees of University College London, UK, used a different technique. They showed volunteers two images in quick succession, with the first flashing so quickly that the subjects couldn't clearly identify it. But by analysing their brain activity, the scientists could identify which image had been shown, even when the subjects themselves didn't remember seeing it.

Together, the two results are remarkable in the sense that they show how the brain reacts to stimuli, even when they are "invisible." If scientists could gain a true understanding of the neural basis of subjective experience through such studies, it might one day make possible reliable prediction of a person's mental state based solely on measurements of his or her brain state.

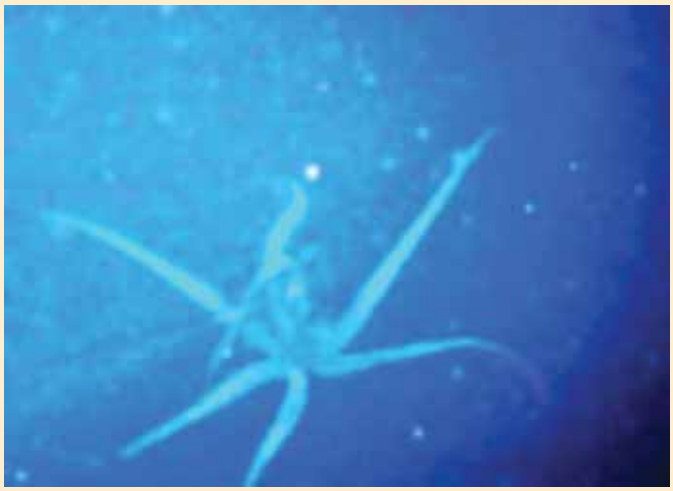
On a different level, another remarkable study of the brain was reported in the American journal *Science* that suggests that our brain may still be evolving. The research, led by Bruce T. Lahn of the University of Chicago, Chicago, USA, focussed on two genes called microcephalin and ASPM. Microcephalin is a gene determining human brain size in molecular evolution. A mutation of the ASPM gene is known to cause primary microcephaly – a neurological disorder in which the circumference of the head is smaller than average for the age and gender of the infant or child. It has been known that when these genes malfunction, the result is a condition in which brain size is severely diminished. Previous studies had indicated that these genes had undergone accelerated evolution at times after the chimpanzee and human lines diverged, hinting they played a role in the emergence of our impressive brain size.

After analysing the genes in an ethnically diverse sample of 90 individuals from around the world Lahn's team found that for both genes, one variant occurred much more frequently than would be expected by chance, suggesting that natural selection is still at work.

Elusive Squid Photographed

In a remarkable feat of wildlife photography of the year, a team of scientists captured images of a live giant squid of the genus *Architeuthis* – the largest invertebrate in the world – in its natural, deep-sea environment. For years, scientists have tried to spy on the colossal squid using different techniques, including observing from remote controlled submarines and strapping cameras to sperm whales, which are known to feed on the giant invertebrates, but success has always eluded them. Triumph finally came to a team of Japanese zoologists Tsunemi Kubodera of the National Science Museum and Kyoichi Mori of the Ogasawara Whale Watching Association, both in Tokyo, Japan, when they captured the elusive creature on camera in the deep ocean waters off the coast of the Ogasawara Islands, an archipelago 1,000 kilometres south of Japan.

More than fours hours of footage show the squid attacking the bait from a horizontal position and then using its tentacles to strangle the prey. The digital pictures not only show how the giant squid attacks its prey, but also suggest that the animal is more aggressive than previously thought. The action caught on camera



Giant squid

contradicts some theories that suggest giant squids are sluggish and use their tentacles to troll for fish.

Flowering Mystery Solved

In the field of plant molecular biology, the year 2005 saw the unravelling of several key molecular cues behind the flowering of plants. In August, three groups of plant molecular biologists in Germany, UK, Sweden and Japan reported how a small molecule that is made in leaves is able to induce the formation of flowers at the growing tip of a plant. Because flowers in turn make fruits and seeds, including cereal grains, this new knowledge could have important applications in crop plants.

Giant squid2

Scientists had known since the 1950s that plants detect day length with their leaves. Since flowers form typically at the tip of branches, researchers concluded that a signal that induces flowering must travel from the leaves to the site where flowers are initiated. Despite these early findings, little progress was seen in pinpointing the hypothetical flower-inducing substance, dubbed 'florigen'. These difficulties have led many scientists to believe that florigen might be not a single entity, but a complex mixture of molecules. In three research papers published in the American journal *Science*, the three teams identified a molecule, called FT, which has all the hallmarks of florigen. The FT gene is induced in leaves within hours after plants receive a stimulus that promotes flowering, but its product, the FT protein, acts at the growing tips of the plant to activate the flowering process. The gap between the two sites is bridged through movement of FT RNA from the leaf to the growing tip.

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Tsunami – A Year After

in a bid to reduce the number of casualties from the future tsunamis. What would be required are three basin-wide technological components - an improved seismic network to locate large earthquakes, about 15 "tsunameters" to detect tsunami waves in less than 30 minutes as they travel across the open ocean, and a real-time network of tide gauges near the shore. Incidentally, a tsunameter consists of a pressure sensor on the deep sea floor that sends an acoustic signal to a buoy at the surface when it senses a passing tsunami. The buoy at the surface then relays the warning via satellite to the centres / officials responsible for sounding the alarm for tsunami. In the meantime, several countries are going ahead with their own interim systems. The Indian early warning system, to be set up at a cost of Rs. 125 crores, is expected to become operational by September 2007. It would also monitor storm surges that occur due to strong cyclonic winds.

However, one must realize that once the warnings are available, they must be disseminated to the people on the coasts. If the first wave arrives after two hours or so, as it would in India or Sri Lanka, people on the coast will have enough time to move inland after the alarm is sounded. In places where the first wave arrives much earlier, the alarm may come too late. They should learn to recognize the natural signs that precede the oncoming wave, say, ground shaking and the sea receding. In both cases quick evacuation of people to safe places is most essential.

Tsunami 2004 was a disaster in which the entire international community, government, non-governmental organizations and individuals responded overwhelmingly. The emergency relief effort in the immediate aftermath of the tsunami disaster was a notable success in all affected countries. Almost no one died from outbreaks of disease, lack of clean water or starvation even in the remote islands. One year on, we have done a reasonably good job in providing relief and rehabilitating the tsunami-affected people. It is heartening to note that most children are back in school, most fishermen have returned to the sea, and a sizeable number have a dwelling of their own. The next phase would be to restore their livelihoods, which may take much longer. For those who have lost their near and dear ones, life may never return to normal. However, our continued commitment to reconstruction may help them overcome the sense of hopelessness and being left out in the rehabilitation process.

❒ V. B. Kamble

Carl Friedrich Gauss

One of the Greatest Mathematicians of All Time

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

"Mathematics is the queen of sciences and arithmetic the queen of mathematics. She often condescends to render service to astronomy and other natural sciences, but in all relations she is entitled to the first rank."

Gauss

"Almost everything, which the mathematics of our century has brought forth in the way of original scientific ideas, attaches to the name of Gauss."

Leopold Kronecker (1823-1891), the German mathematician

"If we except the great name of Newton (and the exception is one which Gauss himself would have been delighted to make) it is probable that no mathematician of any age or country has ever surpassed Gauss in the combination of an abundant fertility of invention with an absolute righteousness in demonstration, which the ancient Greeks themselves might have envied."

Henry Smith(1826-1883), the British mathematician

"Gauss' contributions to mathematics were profound and they have affected almost every area of mathematics and mathematical physics. In addition to being a brilliant and original theoretician he was a practical experimentalist and a very accurate observer. His influence was naturally very great, but it would have been very much greater had he published all his discoveries. Many of his major results had to be rediscovered by some of the best mathematicians of the 19th century, although the extent to which this was the case was revealed after Gauss' death."

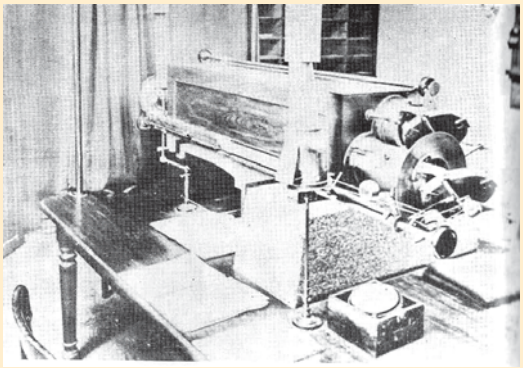
A Dictionary of Scientists, Oxford University Press (1999)

Carl Friedrich is regarded as one of the greatest mathematicians of all time. His biographer G. Waldo Dunnington wrote: "No other name in nineteenth-century mathematics has received recognition equal that of Gauss. His standing in physics and astronomy was perhaps slightly less. Contemporary scholars recognised his unconditional intellectual superiority in his own field. Gauss enjoyed an almost superhuman respect and admiration at the hands of those competent to judge him...Laplace is said to have urged Napoleon to spare Gottingen because "the foremost mathematician of his time lives there."...Gauss' career does not show a gradual rise, as in the case of most scientists; it begins at a high point and continues at that level...In 1805, when the King of Prussia requested Humboldt to enter the Berlin Academy of Sciences in order to lend it the splendour of his name, acquired on the American tour, Humboldt informed the King that his appearance would not be of importance; the only man who could give the Berlin academy new splendour, he wrote, was Carl Friedrich Gauss."

Gauss in 1854

Gauss's work virtually transformed all areas of mathematics. He contributed to almost all branches of mathematics and to number theory in particular. As a mathematician, he was of the stature of Archimedes and Newton. However, in range of interests he exceeded both Archimedes and Newton. In mathematics his chief interest was in the theory of numbers. His monumental work *Disquisitiones arithmetica* (*Arithmatica Investigations*) was the first attempt to organise the theory of numbers. This was published in 1801. Before Gauss' work the theory of numbers was little more than a collection of isolated results. Gauss made important contributions in other areas of mathematics—algebra, analysis, geometry, mechanic, celestial mechanics, probability, the theory of errors, and actuarial science. It was Gauss who gave the first genuine proof of the fundamental theorem of algebra—that every algebraic equation with complex coeficients has at least one root that is a complex number. He also worked in observational astronomy, surveying, geodesy, capillarity, geomagnetism, electromagnetism, optics and the design of scientific instruments. He discovered the Gaussian error curve and also the method of least squares, which he used in his geodesic work.

Gauss was an excellent experimentalist. He invented the heliotrope, (a sextant-like instrument that uses reflected



Gauss' personal laboratory in the Gottingen Observatory as he left it

sunlight for geodetic measurements) for trigonometric determination of the Earth's shape and with Wilhelm Weber (1804-1891), the electromagnetic telegraph. His interest in magnetism also led to the invention of the bifilar magnetometer (in which two silk threads are used for measuring geomagnetic force). Gauss worked on topology and the geometry associated with functions of a complex variables. His researches in mathematical astronomy resulted in many valuable innovations. Gauss obtained a formula for calculating parallax in 1799. In 1808, he published a work on planetary motion. Gauss believed that physical units should be assembled from a few absolute units (mainly length, mass and time), an idea basic to the presently followed SI system.

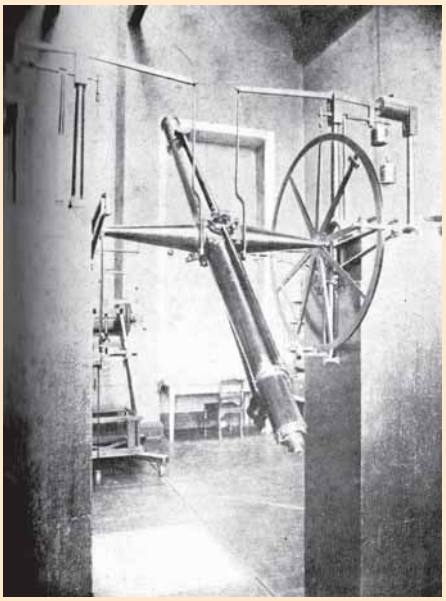
Gauss discovered the possibility of non-Euclidean geometry but he never published it. He discussed this possibility at length with Farkas Bolayi and in his correspondence with Gerling and Schumacher. It is said that Gauss believed that his reputation would suffer if he publicly admitted the existence of such geometry.

Gauss had a very keen interest in language and at one stage he hesitated between a career in mathematics and one in philology. His linguistics ability was such that he was able to teach himself fluent Russian in less than two years. He also had a lively interest in world affairs. However, his views in politics as in literature were somewhat conservative.

Gauss was never a professor of mathematics. However, many of his students turned out to be influential mathematicians. He disliked formal teaching. In a letter to Heinrich Olbers (1758-1840), Gauss wrote: "I have a true aversion to teaching. The perennial business of a professor of mathematics is only to teach the ABC of his science; most of the few pupils who go a step further, and usually, to keep the metaphor, remain in the process of gathering information, become only Halbwisser (one who has superficial knowledge of a subject), for the rarer talents do not want to have themselves educated by lecture cources, but train themselves. And with this thankless work the professor loses his precious time.....Experience also seems to corroborate this. I know of no professor who really would have done much for science, other than the great Tobias Mayer, and in his time he rated as a bad professor."

Gauss had a reputation of being aloof. He possessed the precious gift of being able to make friend with the young. Among his students included Moritz Cantor (1829-1920), Richard Dedekind (1831-1916) and Ferdinand Gotthold Maximillian Eisenstein (1823-1852), Johann Benedikt Listing, August Fardinand Mobius, Bernhard Riemann and Karl von Staudt.

Gauss is best described as a mathematical scientist or, in the terms common in his day, as a pure and applied mathematician. However, Gauss considered himself nothing but a mathematician. Dunnington wrote: "Gauss used to say that he was entirely a mathematician, and he rejected the desire to be anything different at the cost of mathematics. It is true that the research in physical science offered him a type of recreation. He called mathematics the queen of the sciences, and the theory of numbers the queen of mathematics, saying that she often condescended to serve astronomy and other sciences, but that under all circumstances top rank belonged to her. Gauss regarded mathematics as the principal means of educating the human mind." Whatever he did in science he did as a mathematician, motivated by mathematics and utilizing every experience for mathematical inspiration. Clemens Schäfer one of his scientific biographers wrote in *Nature* (1931): "He was not really a physicist in the sense of searching for new phenomena, but

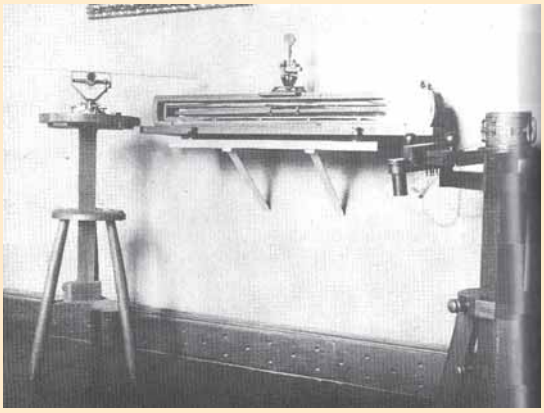


Gauss' principal instrument, the Repsold meridian circle

rather always a mathematician who attempted to formulate in exact mathematical terms the experimental results obtained by others."

The name of Gauss appears in so many places in mathematics and other branches of science. There is hardly any other scientist who can match Gauss on this account. The most common examples are: Gause's principle, Gauss-A position, Gauss B position, Gauss-Bonnet theorem, Gauss-Codazzi equations, gauss (unit), Gauss' error curve, Gauss eye piece, Gauss formulas, Gauss'

hypergeometric equation, Gaussian beam, Gaussian complex integers, Gaussian constant, Gaussian curvature, Gaussian curve, Gaussian distribution, Gaussian elimination, Gaussian error, Gaussian integer, Gaussian noise, Gaussian noise generator, Gaussian optics, Gaussian pulse, Gaussian reduction, Gaussian system, Gaussian units, Gaussian weighing method, Gaussian year, Gauss image point, Gauss-Jordan elimination, Gauss' law of flux, Gauss' law of the arithmetic mean, Gauss-Legendre rule, Gauss lens system, Gauss' mean value theorem, gaussmeter, Gauss objective lens, Gauss point, Gauss positions, Gauss' principle of least constant, Gauss-Seidel method, Gauss test, Gauss' theorem.



The Gausss-weber telegraph (Easten, 1833)

Gauss was deeply religious and conservative. He was deeply preoccupied with the metaphysical issue of immortality. Gauss was a believer of life after death. He was a staunch supporter of the monarchy. He did not like the ascendancy of Napoleon, who he considered as an outgrowth of the revolution. Gauss lived a modest life. Dunnington wrote: "As the son of poor parents Gauss was not accustmed to the luxury of refinements of more modern times. The limited means of his early years were sufficient for his simple needs…Gauss was slow to accept financial aid from others. Throughout his life he remained true to his feelings of humour and intellectual independence…His wants were simple, and material possessions were sometimes regarded by him as exerting a disturbing influence on scientific work."

Gauss was born on April 30, 1777 in Brauschweig, Duchy of Brunswick-Luneburg (now part of Germany) in a lower middle-class family. Gauss' mother was the semiliterate daughter of a peasant stonemason. But she was a highly intelligent woman. She worked as a maid before becoming the second wife of Gauss' father. Gauss' father was a gardener, a labourer at various trades, a foreman, assistant to a merchant and treasurer of a small insurance fund. Gauss described his father as "worthy of esteem," but "domineering, uncouth, and unrefined." Gauss' mother was her son's only devoted support**.**

Gauss' extraordinary talent for mathematics showed itself at a very early age. It is said, that without any help, Gauss was able to calculate before he could even talk. According to a well-authenticated story, Gauss when he was 3 years old, corrected his father's arithmetic. Eric Temple Bell in his book *Men Of Mathematics* , (Simon Schuster, Inc., New York, 1937) described the incident in this way: "One Saturday Gerhardt Gauss (Gauss's father) was making out the weekly payroll for the laborers under his charge, unaware that his young son was following the proceedings with critical attention. Coming to the end of his long computations, Gerhardt was startled to hear the little boy pipe up, 'Father, the reckoning is wrong, it should be ..." A check of the account showed that the figure named by the young Gauss was correct."

In school, when he was in the third grade, he developed a formula for finding the sum of any arithmetic progression. Gauss was ten years old. In his arithmetic class, his teacher had given the class a difficult summation problem in order to keep them busy. Gauss took one look at the problem, invented the shortcut formula on the spot, and immediately wrote down the correct answer. Herr Buttner was so astonished by the feat achieved by young Gauss that he was transformed into a champion for this young boy. Out of his own pocket he paid for the best textbook on arithmetic obtainable and presented it to Gauss. Buttner realised that he could teach this young genius no more and he recommend Gauss to the Duke of Brunswick, Karl Wilhem Ferdinand. The Duke granted him financial assistance to continue his education into secondary school and finally into the University of Gottingen.

In 1792, Gauss entered the Brunswick Collegium Carolinum. Gauss possessed a scientific and classical education far beyond that usual for his age at the time. He was familiar with elementary geometry, algebra, and analysis.

Gauss spent three years at the Collegium, in which he continued his empirical arithmetic, once finding a square root in two different ways to fifty decimal places by ingenious expansions and interpolations. He formulated the principle of least squares, apparently while adjusting unequal approximations and searching for regularity in the distribution of prime numbers. Before entering the University of Göttingen in 1795, he had rediscovered the law of quadratic reciprocity (conjectured by Lagrange in 1785), related the arithmetic-geometric mean to infinite series expansions, and conjectured the prime number theorem (first proved by J. Hadamard in 1896).

Gauss studied at the Gottingen University during 1795 to 1798. At the Gottingen University he had the opportunity to study the mathematics classics and he realized that many of his earlier discoveries were not actually new discoveries. In 1799, Gauss got his doctorate; his dissertation was a brilliant proof of the fundamental theorem of algebra.

In 1801, Gauss published his famous work *Disquisitiones Arithmeticae (Researches in Arithmatic)*, which consisted almost wholly of original work and marked the beginning of modern number theory, an area of

mathematics that Gauss always considered to be the most beautiful. In his *Disquisitiones arithmeticae,* Gauss summarized previous works in a systematic way, solved some of the most difficult outstanding questions, and formulated concepts and questions that set the pattern of research that is still in effect today. He introduced congruence of integers with respect to a modulus, the first significant algebraic example of the now ubiquitous concept of equivalence relation. He proved the law of quadratic reciprocity, developed the theory of composition of quadratic forms, and completely analyzed the cyclotomic equation. *Disquisitiones arithmeticae* almost instantly won Gauss recognition by mathematicians as their prince, but readership was small. G. B. Mathew in his *Theory of Numbers* (Cambridge, 1892) wrote: "It may fairly be said that the germs of the modern algebra of linear substitutions and concomitants are to be found in the fifth section of the *Disquisitiones Arithmeticae*; and inversely, every advance in the algebraic theory of forms is an acquisition to the arithmetical theory."

The courtyard of the Gottinge observatory as it appeared in Gauss time

In this work Gauss led the way to many new areas of mathematics, including the use of imaginary numbers and his theory of congruent numbers.

Immediately following this abstract work in pure mathematics, Gauss plunged into the realm of applied mathematics — in particular, astronomy. The newly discovered asteroid Ceres had been observed by many astronomers for 40 days, but none of them could get a correct computation for its orbit. Gauss was able to accurately compute the orbit after only three observations. This he did by inventing the method of least squares.

The most obvious course, to become a teacher of mathematics, repelled him because at this time it meant drilling ill-prepared and unmotivated students in the most elementary manipulations. Moreover, he felt that mathematics itself might not be sufficiently useful. When the duke raised his stipend in 1801, Gauss told Zimmermann: "But I have not earned it. I haven't yet done anything for the nation." Astronomy offered an attractive alternative. A strong interest in celestial mechanics dated from reading Newton, Gauss had begun observing while a student in Göttingen. The ingenuity on Ceres demonstrated both his ability and the public interest, the latter being far greater than he could expect in mathematical achievements. Moreover, the professional astronomer had light teaching duties and more time for research. Gauss decided on a career in astronomy and began to groom himself for the directorship of the Göttingen observatory.

The birthplace of C.F. Gauss in Brunswick (picture taken 1884) which was destroyed in World War II

In 1807, Gauss was appointed director of the Gottingen observatory, a post he held till his death.

Gauss made significant contributions in the area of differential geometry.His major findings in the field was included in his renowned work, *Dis quisitiones generales circa superficies curva* (1828), which included such geometrical ideas as Gausian curvature and Gauss' famous eregrium theorem. His geodesic interests led him to differential geometry,

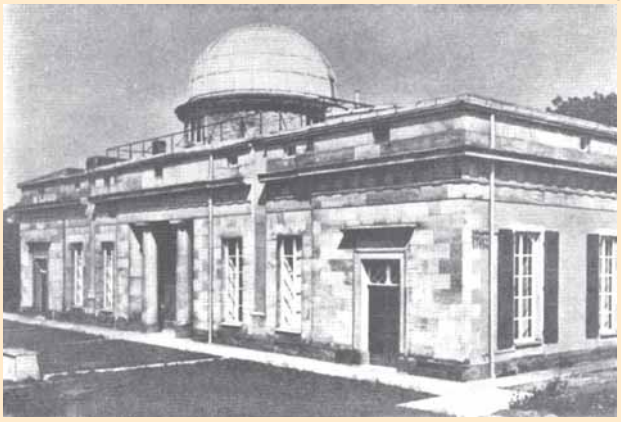
In 1828, Alexander von Humboldt persuaded Gauss to attend the only scientific convention of his career, the Naturforscherversammlung (Nature Research Collection) in Berlin. Humboldt first heard of Gauss from the leading mathematicians in Paris in 1802. Humboldt had been trying to bring Gauss to Berlin as the leading figure of a great academy he hoped to build there. Humboldt had no success in luring Gauss from his Göttingen hermitage. Gauss was repelled by the Berlin convention. However, the visit was a turning point. It inspired him to develop his long standing interest in earth magnetism. During this Berlin visit Gauss met Wilhelm Weber, a young and brilliant experimental physicist whose collaboration was essential for Gauss' work on magnetism. With Weber Gauss established a magnetic observatory. In 1834, Gauss organized the Magnetic Association to conduct Europe-wide geomagnetic observation. This was the first major scientific project based on international co-operation. Later Humboldt expanded the Magnetic Association into a world-wide network.

Gauss undertook the task of re-organisation of the fund for professors' Widows at the Gottingen University. Dunnington wrote: "Beginning in 1845 the academic senate at Gottingen entrusted Gauss with a gigantic task, a study and reorganisation of the fund for professors' widows. He devoted himself to it with his usual vigor; here his mathematical ability and knowledge of financial operations linked up with his practical talent in organising. This job took much of his time as late as 1851, and his work saved the fund from ruin…Gauss received recognition for his achievement, and widows as well as orphans were grateful to him."

Gauss made his last astronomical observation in 1851, at the age of 74, and later the same year approved

Riemann's doctoral thesis on the foundations of complex analysis. The following year he was still working on minor mathematical problems and on an improved Foucault pendulum. During 1853-4, Riemann wrote his great *Habilitationsschrift* on the foundations of geometry, a topic chosen by Gauss. Gauss' last scientific exchange was with Gerling, with whom he discussed a modified Foucalt pendulum in 1854.

Gauss had an intense dislike of controversy. He often remained silent when others announced results that he found decades before. Gauss avoided all noncompulsory ceremonies and formalities. He attended only those ceremonies where royalty was to be present. He hardly collaborated with other mathematicians. He was considered aloof and austere by many. After the Berlin visit, Humboldt wrote Shumacher (October 18, 1828) that Gauss was "glacially cold" to unknowns and unconcerned with things outside his immediate circle.



The observatory of the University of Gottingen

Commenting on the style of Gauss, W. W. R. Ball in his *History of Mathematics* (London, 1901) wrote: "The great masters of modern analysis are Lagrange, Laplace, and Gauss, who were contemporaries. It is interesting to note the marked contrast in their styles. Lagrange is perfect both in form and matter, he is careful to explain his procedure, and though his arguments are general they are easy to follow. Laplace on the other hand explains nothing, is indifferent to style, and, if satisfied that his results are correct, is content to leave them either with no proof or with a faulty one. Gauss is as exact and elegant as Lagrange, but even more difficult to follow than Laplace, for he removes every trace of the analysis by which he reached his results, and studies to give a proof which while rigorous shall be as concise and synthetical as possible."

From 1989 until the end of 2001, Gauss' portrait and a normal distribution curve were featured on the German ten-mark bank note.

Gauss died on February 23, 1855 in Gottingen, Hanover. He was cremated in the cemetery Albanifriedhof.

Gauss worked in mathematics for his own curiosity. He did not publish anything unless complete and perfect. His motto was "*pauca sed matura*—few, but ripe." The notebook and Gauss's papers (unpublished ones) show that he anticipated non-Euclidean geometry as a boy, 30 years before J Bolai (1802-60, son of Wolfgang) and Lobachevsky; that he found Cauchy's fundamental theorem of complex analysis 14 years earlier; that he discovered quaternions before Hamilton and anticipated A-M Legendre (1752-1833), Abel, and Jacobi in much of their important work. If he had published, Gauss would have set mathematics half a century further along its line of progress." According to an exact mathematics historian Gauss had precisely 404 ideas, 178 of which he discussed in print.

Commenting on Gauss' philosophy of life Dunnington wrote: "Gauss' mature philosophy of life was closely connected with his strongly religious nature, which was characterized by tranquility, peace, and confidence. All pretence was especially repugnant to him, and he treated all charlatanism, especially on the scientific side, with disdain and often with bitter irony. He once said that the most despicable human being is the one who persists in his errors after he has recognized them. A thirst for truth connected with an urge for justice was the leading element in his character. The principle of least compulsion was the mathematical embodiment of that basic ethical thought which he recognized as binding on the universe.

All philosophical studies possessed a powerful charm for Gauss' mind, although he often disliked the ways by which scholars arrived at certain viewpoints. He once said to a friend: 'There are questions on whose answers I would place an infinitely higher value than on the mathematical, for example, concerning ethics, concerning our relationship to God, concerning our destiny and our future; but their solution lies quite unattainable above us and quite outside the area of science.'"

We end this article by quoting Gauss. "It is not knowledge, but the act of learning, not possession but the act of getting there, which grants the greatest enjoyment. When I have clarified and exhausted a subject, then I turn away from it, in order to go into darkness again; the never satisfied man is so strange—if he has completed a structure, then it is not in order to dwell in it peacefully, but in order to begin another. I imagine the world conqueror must feel thus, who, after one kingdom is scarcely conquered, stretches out his arms again for others."

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Acknowledgement : The photographs/illustrations have been reproduced from Dunnington's biography of Gauss.

Winter Sense

Prevention and Management of Cold Weather Injuries

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With weather conditions being near arctic over many parts of India, it's not just the cold nip in the air that one's got to worry about. If you are a little sloppy or dress less than ideal for the cold setting, you could walk into a whale of trouble.

You could be hit by chilblains, suffer from frostbite, or even incur hypothermia. The best remedy, as in all cases, is prevention. However, if you, a family member or friend suffers from the inclement weather, common sense first aid measures can ease the damage. Let's see how :

CHILBLAINS

Chilblains result from excessive narrowing of blood vessels under the skin.

They are particularly common in young children, the elderly, and in individuals laid down by chronic invalidism.

Symptoms

Chilblains are reddish-purple swellings, which most commonly affect the fingers, toes and ears in cold weather. They are rather painful when the affected limbs are exposed to cold and are extremely itchy once the skin has become warm again.

Prevention

- Wear sufficient clothing, including gloves, socks, muffler, and a cap, to stay warm. This shall help prevent chilblains.
- Take regular exercise. This would encourage improved blood flow to your hands, feet and other parts of the body, and save them from chilblains.

Treatment

The condition is aggravated by warmth, and sudden re-warming is not recommended. The preferred treatment is to elevate the affected part and allow it to warm gradually at room temperature.

FROSTBITE

Exposure to extreme cold can freeze the body tissues and damage them. The condition is known as frostbite. Frostbite can affect any area of your body. Your hands, feet, nose and ears are most susceptible because they are small and often exposed. The condition develops at any temperature below 0º Celsius. Windy conditions increase the risk.

In subfreezing temperatures, the tiny blood vessels in your skin tighten, reducing the flow of blood and oxygen to the tissues. Unless counteractive steps are initiated in time, cells are destroyed causing loss of tissue.

Persons at risk

Any individual who suffers from an impaired blood circulation is at a higher risk of developing frostbite. Such individuals include those affected with:

- Atherosclerosis (hardening of the arteries)
- Diabetic vascular disease, or
- High blood pressure or a heart condition which requires them to take a beta-blocker medication, such as atenolol

Symptoms

The first sign of frostbite may be a slightly painful, tingling sensation. This often is followed by numbness. Your skin may be deathly pale and feel hard, cold and numb.

Frostbite can damage deep layers of tissue. As deeper layers of tissue freeze, blisters often form. Blistering usually occurs over 1 to 2 days.

Frostbitten areas will turn red and throb, or they will burn with pain as they thaw. Even with mild frostbite, normal sensation may not return immediately. When frostbite is severe, the area will probably remain numb until it heals completely. In extreme cases, healing can take up to six months, and the damage to your skin can permanently change your sense of touch.

First aid

What must you do?

- Carefully and gradually re-warm frostbitten areas. If you are outside, place your hands directly on the skin of warmer areas of your body. Warm your hands by tucking them into your armpits. If your nose, ears or face is frostbitten, warm the area by covering it with your warm hands.
- If possible, immerse your hands or feet in water that is slightly above normal body temperature (100 to 105º F) or that feels warm to someone else.
- Do *not* rub the affected area. *Never* rub snow on frostbitten skin.

- Do *not* smoke cigarettes. Nicotine causes your blood vessels to constrict and may limit circulation.
- If your feet are frostbitten, elevate them after re-warming.
- Do *not* use direct heat (such as heating pads).
- Do *not* re-warm an affected area if there is a chance that it will refreeze.

What your doctor might do?

- In severe cases, in which infection is present after the affected area has been re-warmed, antibiotics may be necessary. Bed rest and physical therapy may be appropriate.
- In very severe cases, and after all other means have been tried, amputation of dead areas may be necessary to preserve the nearby healthy tissue.

HYPOTHERMIA

Under most conditions, your body maintains a healthy temperature. However, when exposed for prolonged periods to cold temperatures or a cool, damp environment, your body's control mechanisms may fail to keep your body temperature normal. When more heat is lost than your body can generate, your body temperature might just dip to subnormal temperature, a condition that's called hypothermia.

Persons at risk

The elderly, the very young and very lean people are more susceptible to developing hypothermia. Malnutrition, heart disease, underactive thyroid and excessive consumption of alcohol can also predispose a person to hypothermia, but even able-bodied individuals, including soldiers, might suffer if they are careless. Let's see why:

Elderly people: As the body ages, its heat generating mechanism becomes less able to maintain its normal body temperature in cold conditions.

Babies: Young babies tend to lose heat rapidly and cannot easily maintain their body temperature.

Hypothyroidism: An underactive thyroid slows down the body's functions and reduces the body temperature.

Chronic invalidism: Individuals suffering from stroke or arthritis whose mobility is reduced are at risk of developing hypothermia since their body produces less heat in comparison to active people.

Abuse of alcohol or drugs: Individuals under the influence of alcohol or drugs may have reduced awareness of low temperature, and thereby suffer hypothermia following exposure to cold.

Walkers and climbers: Hypothermia is particularly common in climbers and walkers who have an uncovered head or are inadequately dressed for cold weather.

Homeless: Each year tens of dozens of homeless people perish of hypothermia when the cold wave worsens. Wet or damp clothing increases the chances of hypothermia.

Symptoms

The key symptom of hypothermia is a body temperature that drops to less than 35 º C (95 º F). Signs include shivering, an abnormally slow rate of breathing, skin that is cold and pale, a loss of coordination and feelings of tiredness, slurred speech, lethargy or apathy. The onset of

symptoms is usually slow; there is likely to be a gradual loss of mental acuity and physical ability. The person experiencing hypothermia, in fact, may be unaware that he is in a state requiring emergency medical treatment.

What can you do?

- If you are with someone who has mild hypothermia, move him or her to a warm sheltered place. Change the person into warm, dry clothing and wrap him or her in a warm blanket. If the person is conscious, give him warm liquids. Do not give the victim alcohol because it can exacerbate the condition.
- If hypothermia is more severe, seek emergency medical assistance. While waiting for help to arrive, monitor the person's breathing and pulse. If either has stopped or seems dangerously slow or shallow, initiate cardio-pulmonary resuscitation (CPR) immediately. If emergency medical care is not available, warm the person with a bath at 100 to 105 º F (warm to the touch but not hot).
- If you are stranded in a remote place with a person with severe hypothermia, follow as many of the self care measures as possible until help arrives. If going indoors is not possible, the person needs to be out of the wind, have the head covered and be insulated from the cold ground. If possible, get into a sleeping bag together. Your body heat will help to warm the person up.

What the doctor might do?

In extreme cases, once the victim has arrived at a medical centre, slow re- warming is carried out, usually in an intensive care unit. With emergency treatment, most people with mild to moderate hypothermia recover fully. However, the outcome for the elderly and very young may not always be favourable.

PREVENTING COLD WEATHER INJURIES

Take the following measures to prevent cold weather injuries:

Stay dry : Your body loses heat faster when your skin is dampened by rain, snow or perspiration.

Protect yourself from the wind : Wind robs more heat from your body than cold air alone. Exposed skin is particularly affected by wind.

Contd. on page 21

Novel Catalysts for Organic Syntheses

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Organic chemistry is fascinating subject. Organic substances are those made up mainly of the element carbon. Carbon atoms can form long chains and rings, bind other elements such as hydrogen and oxygen, form double bonds, etc. All life on Earth is based on these carbon compounds, which occur naturally; but organic compounds can also be produced artificially through organic synthesis.

Organic chemists keep discovering new reactions and catalysts to not only synthesise molecules that occur in nature but also to produce new organic molecules not found in nature. To date only a tiny fraction of the enormous diversity of organic molecules has been explored by synthetic chemists, yet it has already given us new pharmaceuticals, agrochemicals, materials, etc., that we can not live without. Further exploration of this diversity could result in even greater benefits to mankind – the potential is enormous. However, progress demands discovery and access to new selective synthetic methods. Olefin metathesis is one such useful synthetic method. The Nobel Prize for Chemistry for 2005 has been awarded jointly to a French chemist named Yves Chauvin of the French Petroleum Institute and two American chemists Robert H. Grubbs of California Institute of Technology and Richard R. Schrock of Massachusetts Institute of Technology "for the development of the metathesis method in organic synthesis".

Yves Chauvin

In metathesis reactions, certain transition-metal compounds are used as catalysts to break and make double bonds between carbon atoms in ways that cause atom groups to change places. Derived from the Greek words *meta* (change) and *thesis* (position), 'metathesis' is a word meaning 'change positions'. It has been compared to a dance in which the couples change partners. For example, if we take a compound AB and react it with the compound CD using metathesis, the products formed will be AC and BD. Here the groups B and C have changed place during the reaction. Metathesis reactions can be of many types; they include straight swapping of groups between two acyclic olefins (cross-metathesis), closure of large rings (ring-closing metathesis), formation of dienes from cyclic and acyclic olefins (ring-opening metathesis), polymerization of cyclic olefins (ring-opening metathesis polymerization), and polymerization of acyclic dienes (acyclic diene metathesis polymerization). With certain catalysts, new carbon-carbon double bonds are formed at or near room temperature even in aqueous media from starting materials that bear a variety of functional groups.

Robert Grubbs

Richard Schrock

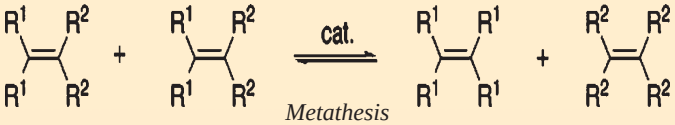
Catalysed metathesis was discovered in the industry following observations in the 1950s of the polymerization of ethylene by the German chemist Carl Ziegler who shared the Nobel Prize for Chemistry in 1963. In 1966 Giulio Natta (co-winner of the 1963 Nobel Prize for Chemistry) and co-workers showed that combinations of tungsten hexachloride (WCl_6) with either triethylaluminum ($AlEt_3$) or diethylaluminum chloride can be used to polymerize cyclo-heptene, cyclo-octene and cyclo-dodecene. Subsequently, in a series of patents novel processes were reported; but their mechanisms were not understood till 1971 when Yves Chauvin was able to explain in detail how metatheses reactions function and what types of metal compound act as catalysts in the reactions.

Chauvin arrived at the mechanism after detailed study of the works of G. Natta on the polymerization of cyclo-pentene through ring-opening catalysed with a mixture of WCl_6 and $AlEt_3$; of Ernst Otto Fischer (co-winner of the 1973 Nobel Prize for Chemistry) on the synthesis of a tungsten-carbene complex; and the works of other researchers on the use of organometallic catalysts in organic synthesis. Chauvin's reaction mechanism was a great step forwards since it showed how the catalyst functions in a metathesis reaction. His work subsequently helped develop the actual catalysts for specific reactions. Researchers were given a new challenge to grapple with: to construct new efficient catalysts.

The so-called 'Grubbs and Schrock' catalysts were developed during research programs taken up in the 1970s. In the mid-1980s, Schrock came up with highly reactive systems based on tungsten and then on molybdenum. The latter were less reactive and therefore more selective in reacting with olefins rather than with other functional groups.

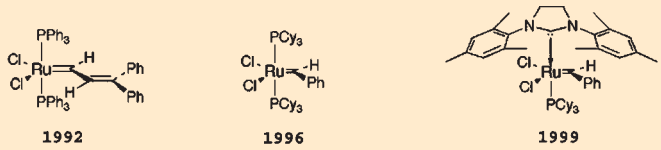
With more selective catalysts at hand, researchers began using them in organic chemistry. In 1990, Richard Schrock was the first to produce an efficient metal-compound catalyst for metathesis. In 1992, this new catalyst, widely known as the 'Schrock catalyst', was used

in ring-closing metathesis to form oxygen and nitrogen heterocycles. In a spectacular example, a team led by Professor Amir H. Hoveyda of Boston College, Massachusetts, USA used the same catalyst in 1995 in a stereospecific synthesis of a 14-membered macrocyclic antifungal compound. This application set the stage for use of olefin metathesis to close big rings carrying many functional groups.



Metathesis

In 1992 Robert Grubbs developed an even better catalyst, using ruthenium, which was stable in air and has found many applications. Many people credit the ruthenium catalysts of Grubbs with putting olefin metathesis in the forefront of organic synthesis. The ruthenium compounds have high preference for carbon-carbon double bonds and are indifferent to alcohols, amides, aldehydes, and carboxylic acids. More important, their use does not require stringent conditions. They can be used by organic chemists applying standard techniques. Vacuum lines and dry boxes, which are needed when working with Schrock's molybdenum catalysts, are not necessary.



Grubbs catalysts

Further refinements to Grubbs's ruthenium catalysts led in 1996 to a new ruthenium catalyst containing a tricyclohexylphosphine (PCy_3) group. The catalyst $(PCy_3)_2Cl_2Ru_5CHC_6H_5$, is now widely known as the 'Grubbs catalyst'. Three years later, Grubbs introduced an even better ruthenium catalyst, the so-called second-generation Grubbs catalyst in which one of the tricyclohexylphosphines

Chauvins' mechanism for metathesis can be viewed as a dance in which the "catalyst pair" and the "alkene pair" dance round and change partners with one another. The metal and its partner hold hands with both hands and when they meet the "alkene pair" (a dancing pair consisting of two alkylides) the two pairs unite in a ring dance. After a while they let go of each other's hands, leave their old partners and dance on with their new ones. The new "catalyst pair" is now ready to catch another dancing "alkene pair" for a new ring dance or, in other words, to continue acting as a catalyst in metathesis.
Source: nobelprize.org

of the Grubbs catalyst is replaced with an N-heterocycle ligand. Since the Grubbs catalysts were introduced in 1996, they have found many uses in organic synthesis.

Considering the short time during which Grubbs' and Schrock's catalysts have been available, the breadth of applications has been remarkable. The synthesis of polymers with special properties, additives to polymers and fuels, and biologically active compounds such as insect pheromones, herbicides and drugs have become possible. With catalytic metathesis it has been possible to get higher yields of products using shorter synthetic routes. It has given the chemical industry novel possibilities to exploit the enormous diversity of organic molecules and contributes to a "greener" chemistry. Catalysts for metathesis have been developed into enormously powerful and versatile tools in organic synthesis and the wealth of synthetic transformations that can be accomplished is astonishing. Metathesis is an example of how important basic science can be applied for the benefit of man, society and the environment, and it all goes to the credit of the three Nobel laureates of this year who have made this possible.

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(Contd. from page 23) **Winter Sense...**

Clothe yourself properly : Wear clothing that insulates, shields and breathes. Layers of light, loose-fitting clothing trap air for effective insulation: wear an inner, and as an outer layer, wear something that's water-repellent and windproof. A nylon windcheater makes an excellent ally.

Protect your head, neck and face : Wear two pairs of socks and shoes tall enough to cover your ankles. Mittens—a covering for the hand that encases the thumb separately and the four fingers together—protect your hands better than gloves. A muffler and a cap are also necessary if it's cold and windy.

Warm yourself : If a part of your body becomes so cold that it is starting to feel numb, take the time to re-warm it before continuing your activity.

Don't touch metal with bare skin : Cold metal can absorb heat quickly.

Plan for trips and outdoor activities : Carry emergency equipment.

Say no to alcohol : Many people nurse a myth that alcoholic beverages can bust cold. The truth is since alcohol dilates the blood vessels it exaggerates the heat loss from the body. Hence, if you intend stepping out on a cold evening, just say 'no' to alcohol.

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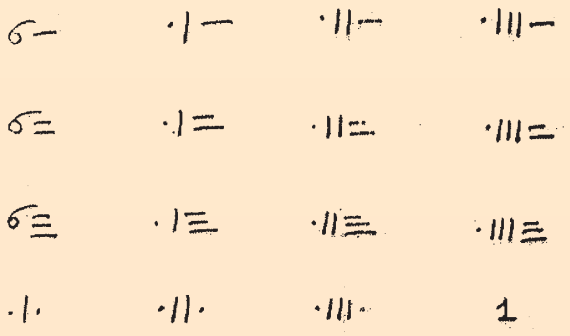
The Forgotten Computer System of India

❑ K.D. Abhyankar

It is well known that the symbol zero and its use in the decimal notation of numbers were discovered in India. But not many persons are aware of another Indian system akin to the modern computer language, which was prevalent here well after independence. In fact, we, of the previous generation, were taught the arithmetic of this system in the school, because it was in daily use. However, the present generation is not at all familiar with it. A look at this system will impress upon the reader that computer mathematics has also its base in the Indian culture.

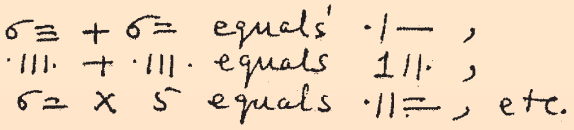
In computers one uses the binary notation system in which the numbers 1,2,3,4 etc. are written as 1, 10, 11, 100 etc. This makes the computations fast by electronic circuits, but it is cumbersome for writing even ordinary numbers. For example, one thousand has to be written as 1111101000. Hence, in earlier days of computes, the decimal numbers were converted into octals, in which 8 is denoted by 10, 64 by 100, etc. Thus one thousand can be written as 1750, which is achieved by combining every three digits of the binary number into an octal digit.

The older Indian system of money (rupee) and weights (*ser*) was based on the quaternary system in which the base is 4 . Each rupee was divided into four quarters and each quarter was further divided into four *anas*. Similarly, each *ser* was divided into four quarters and each quarter was divided into four *chhataaks*. The lowest units, namely, *anas* and *chhataaks*, both were denoted by horizontal lines, while the quarters were denoted by vertical lines. Thus the sixteen parts were denoted as follows:



Thus २।।– meant two rupees and nine *anas*. As can be seen, the symbol ৩ was used to indicate that there was nothing to the left of the *ana chhataak* symbol. Similarly the dots indicated that there was nothing to the left or right of the quarters symbol. In fact, it is these symbols which were later converted into the conventional zero symbol.

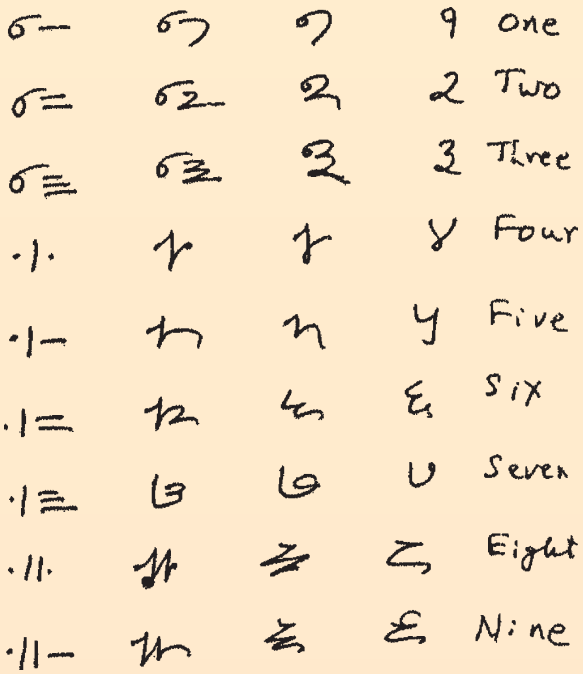
The basic operations had to be done in the quarternary system. Thus,



This system was extremely convenient and easy for the common people, because it involved nothing but halving or doubling. A vegetable vendor or grocer could carry on with just one weight without much difficulty, although he might have to weigh in several instalments. He could also make use of simple rules like.

'As many rupees per *ser* as *anas* per *chhataak*'.

It is quite conceivable that the symbols for the decimal numbers themselves came from the older quarternary system. A possible transformation into numbers is indicated below :



The reader will not appreciate why older people called pure gold as sixteen *ana* gold which is 100 per cent gold. Similarly, halves, quarters and three-eights of any quantity, such as the thickness of wood in inches, was denoted by eight *anas*, four *anas* and six *anas*, respectively.

For completeness of the system we may note that in the case or money, each *ana* was further divided into four paise, which were denoted by vertical lines. In order to distinguish between quarter rupee and a *paise* the symbol ৩ was put before the vertical line instead of dot. Thus ৩।।। represented three paise while ·।।।· denoted twelve *anas*. However, as far as weights were concerned, the *chhataak* was divided into 5 *tolas*, each *tola* into 12 *maasas* and each *maasa* into 8 *rattis*. Similarly for higher weights one used a *dhadi* of 5 *sers* and a *maund* of 8 *dhadis*. It is interesting to note that while 8 is a part of the binary system, the numbers 5 and 12 occurring here are equal to the number of years in *yuga* and the number of months (*maasas*) in a year, respectively.

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Recent Developments in Science &Technology

Mineral analysis may reveal life on Mars

Minerals - as opposed to organic compounds - could reveal the presence of ancient life on Mars, a new study reports. The research suggests relatively simple experiments aboard future landers or sample-return missions to the Red Planet could be used to test for life.

Some evidence suggests Mars was warm and wet in its first hundred million years, raising the possibility that it could have fostered life. But neither of the two Viking landers found organic molecules when they studied the planet's soil in the 1970s.

Now, researchers led by Fabien Stalport of the University of Paris in France say inorganic compounds, which tend to survive longer than their organic counterparts, may act as "tracers of biological activity". To test their idea, they studied the mineral calcite, which is the crystallised form of calcium carbonate.

On Earth, calcite is formed in three ways. Living organisms create biotic calcite – limestone, for example, is produced when biologically formed calcite falls to the ocean floor. Alternatively, geologic processes such as magmatism can form abiotic calcite. And a combination of processes, which might include biological ones, can act on existing rocks to produce diagenetic calcite.

Source New Scientist.com

Researchers Identify Human Skin Color Gene

Ten years ago researchers embarked on a study of zebrafish—a quick breeding aquarium pet. While searching for cancer causing genes, they ended up isolating the gene that makes European skin white, thanks to the golden variant of the fish.

The genetic basis for human skin color has eluded scientists for years, with previous studies pointing to more than 100 different genes involved in the production of melanin—the pigment responsible for skin color and a natural sunblock. Cancer geneticist Keith Cheng at Pennsylvania State University and his team determined that the golden zebrafish—a lighter version of its "wild" cousin—has a genetic mutation that cuts short a protein critical to the production of melanin.

Simply adding the normal length protein to the golden zebrafish returned it to a darker color. More significantly, adding the human gene *SLC24A5,* which is responsible for production of that protein in people, to zebrafish embryos also restored the darker coloration.

Using the human genome database, the so-called HapMap, the researchers found that *SLC24A5* has just two variations. Nearly all humans of European descent have a version of the gene with one type of amino acid, threonine; nearly everyone else The researchers then measured the effect of this gene in 308 individuals of mixed European and African heritage and determined that those who predominantly carried the threonine variant of *SLC24A5* were the lightest, whereas those who predominantly carried the alanine type were the darkest. The findings of this research have been published in the journal Nature.

Source : Scientific American.com

New Pain Reliever Proves More Potent, Less Addictive

Morphine and other opioids work wonders for pain. Unfortunately, their effectiveness declines over time while their addictiveness grows, meaning patients need the drug even as it affords them less and less relief. But new research into the cellular workings of opioids offers a promising new pathway to improved pain relief—without the addiction—by triggering one receptor and blocking another

Medicinal chemist Philip Portoghese of the University of Minnesota and his colleagues began by studying two of the four major opioid receptors in the cells of the central nervous system. Each bears the name of a Greek letter and the chemists focused on the mu and delta receptors. Previous research had shown that drugs that linked up with mu receptors lasted longer with less addiction when combined with drugs that blocked delta receptors. But it was not known whether the two channels worked separately or in concert to improve the overall effect.

So Portoghese and his colleagues built a drug that triggered the mu receptor while blocking the delta receptor—dubbed MDAN, for Mu Delta agonist antagonist. They administered various versions of the drug to mice and then tested their sensitivity to pain by focusing a hot light on their tails and recording the time it took the animals to move them. The MDAN drug proved roughly 50 times more effective than morphine in blocking pain, the researchers report have been published in journal of *National Academy of Sciences.*

Source: Scientific American.com.

Compiled by : Kapil Tripahi

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Edusat Interactive Terminal Network : Orientation Programme

VP's Qutab Institutional Area office. The participants were given an overview of the teaching end operation. Subsequently hands-on practical training was imparted to the participants to handle and operate the SITs. For this purpose, a classroom terminal was set up at CIET. Participants learned to log on and network with the teaching end operated from Vigyan Prasar.

The final session was devoted to a discussion on the various kinds of programmes and formats suited for various groups, say students, women, general public etc. Dr T V Venkateswaran, Scientist, VP, outlined the various types of programmes that could / would be telecast from the teaching end. He emphasized that although VP's network is primarily for science communication, it could also be activated as an emergency communication network in case any natural disaster taking place. Dr. V.B. Kamble and Dr. S. Mahanti shared their views with insightful ideas. Professor Puran Chand, Director, CIET and Joint Director, NCERT, observed that the programmes being developed by VP and CIET could be shared by both the agencies. Dr Dharam Prakash, CIET, and Dr Rajaram, NCERT, also participated in the discussions.