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INDIA ENTERS NEW ERA OF SPACE APPLICATION

India embarked on a landmark journey into a new era of space application with the successful launch of its first navigation satellite ISNSS-1A on Monday. The satellite was launched by India's space workhorse PSLV on its 23rd consecutively successful mission. The PSLV C-22 rocket carrying the satellite lifted off at from Satish Dhawan Space Centre, India's space port in the southern state of Andhra Pradesh, at 11.41 p.m. on Monday. It was the first night-time launch of a satellite from Indian soil. The launch was perfect and the satellite was released into orbit 20 minutes later. IRNSS-1A is the first of seven satellites of the Indian Regional Navigation Satellite System, or IRNSS, an indigenous version of the Global Positioning System, operated by the US. The satellite weighs 1,450 kilograms and has a working life of 10 years.

Monday's launch was the first step in India's plans to develop its own global positioning system by setting up a constellation of seven satellites by 2015. The remaining six satellites will be launched every six months over the next 30 to 36 months. The system will become operational once all the seven satellites are in position. When fully operational, the system will provide two types of services: standard positioning service and restricted service. The first will be provided to all users while the second will be an encrypted service for authorised users such as the military and security. Currently, the US-based Global Positioning System or GPS and Russia's GLONASS are the only two satellite-based navigation systems in operation. China, Japan and Europe are in the process of developing their own regional navigation satellite systems.

The seven satellites of the Indian system, which are being indigenously designed and built, will provide accurate positioning services for users across India and up to 1,500 kilometres beyond its borders. They will provide an absolute position accuracy of better than 10 metres. The system is intended to provide navigation services on land, sea and air and also help in disaster and fleet management. Like GPS, the services of IRNSS will be accessible with mobile phones. An advantage of the Indian system is that the design of the payload makes the IRNSS system inter-operable and compatible with existing GPS.

Unlike the GPS and GLONASS, which use 24 satellites each, the Indian system is based on only a constellation of seven satellites. All seven navigation satellites of the system will be placed at a height of about 36,000 km, which will make them circle the Earth once in 24 hours, making them constantly accessible day and night. Three of the satellites will be placed directly over the equator, in the geostationary orbit from where they would appear from the ground to remain at a fixed position in the sky. The remaining four satellites will be in pairs in two inclined geosynchronous orbits. From the ground, these satellites will appear to move in a figure-of-8 path in the sky during the course of a day. This would mean that from any location in India and at any time, all the satellites will be visible from ground and their navigational services can be accessed. Unlike GPS satellites, none of the satellites of the Indian system will ever go below horizon and out of link with the user.

The perfect launch of PSLV C-22 on Monday adds another feather to ISRO's cap. The reliability rate of PSLV has been superb. With the latest mission, there have been 23 continuously successful flights of PSLV. It has three variants, the most powerful being the extended version called PSLV-XL, fitted with more powerful, stretched strap-on boosters, which was used for

Monday's launch. This success will not only boost India's stature among the spacefaring nations of the world, but also strengthen the country's resolve to make the best of space technology for national development and self-reliance.

INDIA JOINS ARCTIC COUNCIL AS OBSERVER

The announcement on 15 May 2013 of India joining the eight-nation Arctic Council as an observer came as a big morale booster for India's five-year-old Arctic Programme. The new status gives India a foothold in the future of the resources-rich Arctic Ocean as the ice melts and everything from navigation to deposits of oil, gas and minerals become available for exploration and exploitation. The Arctic also has rich reserves of gold, tin, lead, nickel and copper that would offer tremendous potential and opportunities in the future. The Arctic riches have set off a global competition for influence and economic opportunities in the region.

The Arctic Council comprises eight Arctic nations: Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, and the US. Along with India, China, Italy, South Korea, Japan and Singapore also joined the council as observers. Observer status gives countries the right to attend meetings and propose and finance policies.

Although India is not an Arctic state, as one of the rising economies of the world, it has a stake in the Arctic Ocean and would like to be able to influence the decisions taken by the permanent members, especially on matters involving sharing of resources of the region. India is a signatory to the Svalbard Treaty of 1920, which permits it to operate in the Svalbard archipelago, which is under the sovereign control of Norway.

India launched its first scientific expedition to the Arctic in August 2007 to mark the beginning of long-term scientific research by Indian scientists through global scientific endeavour in the region. An Arctic research station named 'Himadri' was launched at Ny-Alesund in Svalbard region of Norway on 1st July 2008. An MoU was also signed between National Centre of Antarctic & Ocean Research, an autonomous body under India's Ministry of Ocean Development, and the Norwegian Polar Research Institute on cooperation in polar research. Since 2007 four Indian scientific expeditions to the Arctic have been undertaken. Scientists of India's National Institute of Oceanography have also been visiting the Arctic region to collect data for climate change studies.

India has a three-fold interest in the Arctic, namely, environmental protection, economy, and policy. The interest in the Polar region is determined by the need to study global phenomena such as climate change. Research made by Indian scientists shows that by the end of 21st century the average global temperature is likely to go up by 3-6 degrees Celsius. Another vital issue is the impact of the Northern Polar region on the strength of monsoons in South Asia. The Indian specialists have detected this relation but not yet figured out the mechanisms. The volume of monsoon rains is critically important for agriculture in India.

All the above factors led to a rapid intensification of Indian scientific research in the Arctic. The Arctic exploration has become a priority program for India to strengthen the economic and political positions of the country in this region. That is why, in its application to the Arctic

Council, India had focussed on its science and technology expertise as the primary reason for joining up.

India still doesn't have sufficient capabilities for taking up large-scale projects in the Arctic, but it is dedicated to secure a footing in the Arctic with the assistance of its partners. Now the observer status in the Arctic Council will make it possible for India to actively get involved and to conduct the Arctic research at the world level standards.

THIRTY METRE TELESCOPE: A NEW WINDOW TO THE UNIVERSE

After the Large Hadron Collider at CERN, Indian scientists are again going to contribute significantly to yet another international mega science project – the Thirty Metre Telescope (TMT). Dubbed as the world's most advanced ground-based observatory operating in optical and mid-infrared wavelengths, the giant telescope will be built just below the summit of Mauna Kea volcano in Hawaii. The total cost of the TMT project is estimated at about $1.4 billion out of which India's contribution will be about $140 million (about Rs.770 crore). Seventy-five per cent of India's contribution will be in the shape of key components and software for the telescope and the rest in cash. India's contribution to TMT will be jointly funded by the Department of Science and Technology and Department of Atomic Energy, Government of India. The other partner nations contributing to TMT are China, Japan, Canada and the US.

The Thirty Metre Telescope is a reflecting telescope. As the name suggests, it will use a mirror with an effective diameter of 30 metres that will have nine times the light-collecting area of the largest optical telescopes in use today. But it will not be a single-piece mirror; it will be made up of 492 hexagonal mirror segments, each 1.44 m in size, 74 of which will be fabricated in India. India will also provide the complete segment support assemblies consisting of the edge sensors and actuators for the TMT. A major part of the observatory control software will also be developed and provided by India.

The TMT will use 'adaptive optics' to counter atmospheric turbulence. In adaptive optics, a computer-controlled deformable mirror is used to correct wave front errors in an astronomical telescope, allowing astronomers to achieve an unprecedented sharpness of faint astronomical sources at optical wavelengths.

Despite being ground based, the TMT will be much more powerful than the orbiting Hubble Space Telescope or the upcoming James Webb Space Telescope because of the enormous light gathering power of its giant primary mirror. When completed in 2021, the TMT will allow astronomers to directly explore the early Universe, from the end of the cosmic dark ages through the formation of the first stars and re-ionisation and into the epoch of galaxy formation.

India's involvement in the TMT project is recognition of its capability in astronomical research and offers a unique opportunity to carry out frontline research in astronomy. It will also help develop cutting-edge science and technology that is required to build and operate the next-generation observatories. It will also provide Indian astronomers and students a share of the observation time at TMT.

INDIA PLAYS KEY ROLE IN BUILDING ITER

The international nuclear fusion project known as ITER (International Thermonuclear Experimental Reactor) is based on the 'tokamak' concept of magnetic confinement in which the plasma is contained in a doughnut-shaped vacuum vessel. India is a major partner in this biggest scientific collaboration on the planet. India is developing the heaviest and the largest parts of the Tokamak, aimed at producing unlimited supplies of cheap, clean, safe and commercial energy from atomic fusion.

The fuel used in the machine will be a mixture of deuterium and tritium, two isotopes of hydrogen, which will be heated to temperatures in excess of 150 million degrees Celsius forming hot plasma. The temperature within the gigantic machine will, therefore, reach 10 times the temperature at the core of the Sun.

Strong magnetic fields will be used to keep the plasma away from the walls. Superconducting magnets will be kept at liquid helium temperature in the world's largest high-vacuum cold storage vessel which will be fabricated in India for ITER. Scientists and engineers at the Institute of Plasma Research (IPR), in Gandhinagar near Ahmedabad will manufacture this mammoth cryostat in segments at a cost of 100 million euros and ship it to France for being assembled at the site. The ITER cryostat will be a fully welded stainless steel cylindrical vacuum/pressure chamber with overall dimensions of roughly 29.4 metres in diameter, 29 metres in height and a finished weight of 3,850 metric tons.

ITER-India Project, a part of the IPR – an autonomous unit of the Department of Atomic Energy, will make the 'in-kind' contributions including the cryostat that form India's share to the ITER project. The cryostat is very crucial to the ITER experiment. It houses the fusion reactor in its entirety, including support to all internal systems. The first of the ITER cryostat's components will arrive on site from India beginning December 2015.

CYBER SECURITY – A GROWING CHALLENGE

Cybercrime is a term used to broadly describe criminal activity in which computers or computer networks are used as a tool, a target, or a place of criminal activity. It includes everything from electronic cracking to web defacement, virus and malware attacks, and denial of service attacks. Of late, mobile phones have become a major target for committing cybercrime. The term is also used to include traditional crimes such as theft, fraud, forgery, defamation and mischief, in which computers or networks are used to enable the illicit activity.

Often the malicious codes or malware pass through our computer security system when we access a particular website or open an e-mail. These codes exploit the loopholes in various applications and insert themselves within the computer system which enables them to replicate and infect other computers by attaching themselves to the e-mails that we send out through our local network.

Cyber security is actually aimed at reducing cybercrimes. It is really all about protecting our personal information or any kind of digital asset stored in our computers or in any digital storage

device. There are different kinds of threats that we could encounter in cyberspace and each one has its own degree of seriousness which requires a certain level of solutions. The threats range from simple malicious codes, otherwise known as malware and spywares, to serious virus that can erase the whole contents of our computer, and hackers that can access and use our personal information for their own personal gain. The higher the level of the threat, the more advanced or complicated the approach would be to implement safety measures to protect ourselves from such harm.

Cyberspace security is a global challenge – one that cannot be solved by a single company or country alone. The defence of cyberspace has a special feature. The national territory or space that is being defended by the land, sea and air forces is well defined. Outer space and cyberspace are different. They are inherently international, even from the perspective of national interest. So it is not possible for a country to ignore what is happening in any part of this space if it is to protect the functionality of the cyberspace relevant for its own nationals.
The effectiveness of cyber security measures are limited at present because the technologies that are used in cyberspace are still very new and are still evolving. Hence investing in technological capacities to keep track of global developments, developing counter-measures and staying ahead of the competition is as central to cyber security as the more conventional security measures. Significantly, the Indian government declared that it would invest around 200 million US dollars in the next four years to strengthen cyber security infrastructure.

NATIONAL CYBER SECURITY POLICY

The government has formulated the National Cyber Security Policy 2013 with the prime objective of protecting information and building capabilities to prevent cyber-attacks and safeguard both physical and business assets of the country. There is need to protect critical infrastructure such as air defence system, power infrastructure, nuclear plants, telecommunications system to thwart attempts to create economic instability. The cyber policy was necessary in the wake of possible attacks from state and non-state actors, corporates and terrorists as the Internet world has no geographical barriers and was anonymous in nature.

The policy lays out 14 objectives which include creation of a cyber-ecosystem in the country, providing fiscal benefits to businesses for adoption of standard security practices and processes, developing effective public private partnerships and collaborative engagements through technical and operational cooperation.
The main objectives of the new policy would be:

- To develop suitable indigenous security technologies through frontier technology research, solution oriented research, proof of concept, pilot development, transition, diffusion and commercialisation leading to widespread deployment of secure ICT products/processes in general and specifically for addressing National Security requirements.
- To create a workforce of 500,000 professionals skilled in cyber security in the next 5 years through capacity building, skill development and training.
- To enable protection of information while in process, handling, storage and transit so as to safeguard privacy of citizen's data and for reducing economic losses due to cyber-crime or data theft.

- To develop effective public private partnerships and collaborative arrangements through technical and operational cooperation and contribution for enhancing the security of cyber space.
- To enhance global cooperation by promoting shared understanding and leveraging relationships for furthering the cause of security of cyber space.

In order to create a secure cyber ecosystem, the policy plans to set up a national nodal agency to coordinate all matters related to cyber security in the country with clearly defined roles and responsibilities.

The policy plans to operate a 24×7 national level computer emergency response team (CERT) to function as a nodal agency for coordination of all efforts for cyber security emergency response and crisis management. All organisations would be asked to earmark a specific budget for implementing cyber security initiatives and for meeting emergency response arising out of cyber incidents.

THE SCIENCE, TECHNOLOGY AND INNOVATION POLICY 2013

The Government of India announced the Science, Technology and Innovation Policy (STI) 2013 in January 2013. The new Policy seeks to send a signal to the Indian scientific community, both in the private and public domain, that science, technology and innovation should focus on faster, sustainable and inclusive development of the people. The policy seeks to focus on both STI for people and people for STI. It aims to bring all the benefits of Science, Technology and Innovation to the national development and sustainable and more inclusive growth. It seeks the right sizing of the gross expenditure on research and development by encouraging private sector participation in R & D, technology and innovation activities.

The policy also seeks to trigger an ecosystem for innovative abilities to flourish by leveraging partnerships among diverse stakeholders and by encouraging and facilitating enterprises to invest in innovations. It also seeks to bring in mechanisms for achieving gender parity in STI activities and gaining global competitiveness in select technological areas through international cooperation and alliances. The policy goal is to accelerate the pace of discovery, diffusion and delivery of science led solutions for serving the aspirational goals of India for faster, sustainable and inclusive growth. A Strong and viable Science, Research and Innovation system for High Technology led path for India (SRISHTI) are the goal for the STI policy.

The key features

- Promoting the spread of scientific temper amongst all sections of society.
- Enhancing skills for applications of science among the young from all social sectors.
- Making careers in science, research and innovation attractive enough for talented and bright minds.
- Establishing world class infrastructure for R&D for gaining global leadership in some select frontier areas of science.
- Positioning India among the top five global scientific powers by 2020 (by increasing the share of global scientific publications from 3.5% to over 7% and quadrupling the number of papers in top 1% journals from the current levels).
- Linking contributions of scientific research and innovation system with the inclusive economic growth agenda and combining priorities of excellence and relevance.
- Creating an environment for enhanced private sector participation in R &D.

- Enabling conversion of R & D output with societal and commercial applications by replicating hitherto successful models, as well as establishing of new PPP structures.
- Seeking S&T-based high risk innovation through new mechanisms.
- Fostering resource optimised cost-effective innovation across size and technology domains.
- Triggering in the mindset and value systems to recognise respect and reward performances which create wealth from S&T derived knowledge.
- Creating a robust national innovation system.

GREEN INTERNET

Internet-based technologies come at a cost – extensive energy consumption. A few technologies have been developed to reduce energy wastage during Internet use and more are in the offing. Around the world, data centres consumed over 270 terawatt hours (TWh) of energy in 2012 and it is estimated that they will consume about 20 per cent more in 2013.

Current networks, devices and data centres do not have power management options. Consumption remains high even when there is low level of Internet traffic, leading to wastage of energy. So, technologies are being developed to make these networks more energy-efficient. New technologies "smart standby" allows unused parts of a network to be put into very low power states and save energy. Another technology called "Dynamic frequency scaling" ensures that when the system is under partial load, parts of it can be cut off without hitting overall performance.

Some of these technologies are still beset with glitches. For instance, smart standby make hardware take a long time to wake up. Certain aspects of the problem have been identified that can be streamlined to take care of such problems.

Using these technologies, over 50 per cent of the energy being spent on Internet traffic currently can be saved. Some US companies that manufacture networking equipment are already implementing greening techniques in their devices.

Both telecom industries and producers of electronic devices need to work closely in developing new devices with energy saving devices. The next generation of devices would be able set up and synchronise their energy-saving capabilities. Once new green devices are available, the only barrier would be to replace the old equipment, which may involve huge costs. But appropriate government subsidies as incentives could encourage users to opt for green devices for networking.

INDIA'S MARS MISSION

India is planning to send an unmanned mission to Mars later this year. Named *Mangalyaan* it will be an absolutely indigenous mission any foreign involvement. The project would mark another step in India's ambitious space programme, which placed a probe on the Moon four years ago and envisages its first manned orbital mission in 2016.

Mangalayaan will be a purely scientific mission. The Rs 450-crore project will carry 24 kg of payload experiments – cameras and sensors to study the upper atmosphere as well as the "chemical and mineralogical" features of the Red Planet and send data continuously back to Earth. The spacecraft will be launched by ISRO's polar satellite launch vehicle (PSLV-XL) and will be placed in an orbit around Mars with farthest and nearest orbital points of around 80,000 km and 500 km respectively.

The technological objective of the mission is to design a spacecraft capable of reaching Mars and getting into orbit around the planet. This will take around nine months. Another technological challenge is to realise related deep space mission planning and communication management at a distance of nearly 400 million km.

The *Mangalyaan* mission is currently scheduled to take off in November 2013 and will take around eight months to reach the Red Planet. However, it does not take off as scheduled, ISRO scientists will have to wait at least until 2016 to get the required favourable distance from Mars again followed by another window in 2018 when the planet will be closest to the Earth.

If all goes well, India will be the sixth country to launch a mission to the Red Planet after the US, Russia, Europe, Japan and China. According to former ISRO chairman and Planning Commission member K Kasturirangan, "The mission will be a technology demonstrator. A successful mission will prove that we have capability to reach the far away planet and orbit around Mars. This will pave the way for more intense exploratory missions in future."

PRINTING IN 3 DIMENSIONS

3D printing is a process of making a three-dimensional solid object of virtually any shape from a digital model. 3D printing is achieved using an additive process, where successive layers of material are laid down in different shapes. 3D printing is considered distinct from traditional machining techniques, which mostly rely on the removal of material by methods such as cutting or drilling (subtractive processes).

A materials printer usually performs 3D printing processes using digital technology. The 3D printing technology is used for prototyping and distributed manufacturing with applications in architecture, construction, industrial design, automotive, aerospace, military, engineering, civil engineering, dental and medical industries, biotech (human tissue replacement), fashion, footwear, jewellery, eyewear, education, geographic information systems, food, and many other fields.

To perform a print, the machine reads the design from an .stl or stereolithography file and lays down successive layers of liquid, powder, paper or sheet material to build the model from a series of cross sections. These layers, which correspond to the virtual cross sections from the CAD model, are joined or automatically fused to create the final shape. The primary advantage of this technique is its ability to create almost any shape or geometric feature. Traditional

techniques like injection moulding can be less expensive for manufacturing polymer products in high quantities, but additive manufacturing can be faster, more flexible and less expensive when producing relatively small quantities of parts. 3D printers give designers and concept development teams the ability to produce parts and concept models using a desktop size printer.

Though the printer-produced resolution is sufficient for many applications, printing a slightly oversized version of the desired object in standard resolution, and then removing material with a higher-resolution subtractive process can achieve greater precision.

MAKING INDIA A GLOBAL SOLAR ENERGY HUB

Addressing the Fourth Clean Energy Ministerial meeting in New Delhi in April 2013, Prime Minister Manmohan Singh urged global companies on to make India a solar energy hub as the country seeks to cut its chronic power shortages. The meeting was attended by representatives of over 20 nations. India, which has an average of 300 sunny days a year, sees solar power as a potentially vital energy source that could be key to boosting power supplies and reducing greenhouse gas emission in the world's third-worst carbon polluter.

India is working urgently to develop alternative power sources and wean itself away from polluting coal-fired generation to power an economy that is expected to grow by at least six per cent this financial year. It has just 551 megawatts of solar capacity installed currently, according to government figures, and some 70 per cent of the equipment comes from abroad.
India's National Solar Mission launched in 2010 aims to generate 20 gigawatts of solar power by 2022 – equivalent to one-eighth of the nation's current installed power base. The solar energy drive is also part of efforts to tackle frequent power outages especially in rural India that economists say knock an average 1.2 percentage points off annual growth. But barriers to widespread introduction of solar power such as lack of technology and subsidies to consumers remain. Once installed, however, experts say the costs are low and are mainly confined to maintenance. The Indian government has unveiled draft legislation that would allow the solar industry to obtain grants covering up to 40 per cent of installation costs.

TURNING GARBAGE INTO GAS

Delhi produces more than 8,000 tonnes of garbage the disposal of which is becoming an uphill task for the municipal authorities. Delhi has run out of land for landfills, and none of the neighbouring States intends to surrender any to meet its needs.

The obvious answer to Delhi's problem seems to be to burn the solid waste. Cities all over the world are doing it. The Delhi Municipal Corporation's effort to reopen a small waste incineration plant at Timarpur, that had been closed down soon after it was built in 1980s did not succeed. It was proposed to use the plant to convert 214,000 tonnes of solid waste a year into 69,000 tonnes by sifting out inorganic matter, and drying and palletising the rest to increase its fuel value. Burning this garbage, it was estimated, would produce six megawatts of power per hour, or 5.5 billion units of electricity a year.

At present Delhi has one incineration plant at Okhla, burning almost 2,000 tonnes a day, and two more are being set up to incinerate another 4,300 tonnes a day. What's more, these plants will generate 50 MW of power every hour of the day. More incineration plants are on their way: since the Okhla plant went on stream, the Union Ministry of Environment and Forests has approved eight more plants in various cities.

However, garbage burning plants pose some health threats. The threats come from particulate emissions that greatly exacerbate lung diseases from bronchitis and asthma to emphysema and lung cancer, and from dioxins and furans in addition to the usual nitrogen and sulphur oxide gases in the flue gas.

A better way of disposing garbage that not only eliminates all pollutants, but turns garbage into fuel is to gasify garbage. Gasification is an incomplete combustion of organic matter that replaces a large part of the carbon dioxide we get from combustion with carbon monoxide and hydrogen. These two gases are, and have been for a hundred years, the basic building blocks of the world's petrochemicals industry. They are also ideal for driving gas turbines to generate power. From India's perspective, their best feature is the ease with which they can be synthesised into any transport fuel one desires. Gasification also eliminates the threat from dioxins.

Ironically, India already has employed plasma gasification technology — for the past four years, two 68 tonnes-a-day commercial plants employing this technology have been disposing of medical and other hazardous wastes in Pune and Nagpur. Since Indian states do not share information, however, these have remained isolated ventures.

NANOGRAPHENE: A NEWLY SYNTHESISED CARBON FORM

A new form of carbon has been reported is a wildly distorted from of graphene, with five 7-membered rings and one 5-membered ring embedded in the hexagonal lattice of carbon atoms. The new form of carbon was synthesised by chemists at Boston College in USA and Nagoya University in Japan. This new material consists of many identical piece of grossly warped graphene, each containing exactly 80 carbon atoms joined together in a network of 26 rings, with 30 hydrogen atoms decorating the rim. These individual molecules, because they measure somewhat more than a nanometre across, are referred to generically as "nanocarbons," or more specifically in this case as "grossly warped nanographenes."

Until recently, scientist had identified only three forms of pure carbon, namely: diamonds, graphite, and fullerenes. Since the discovery of fullerenes in 1985, scientists have also learned how to make long, ultra-thin, hollow tubes of carbon atoms, known as carbon nanotubes, and large flat single sheets of carbon atoms, known as graphene.

Graphene sheets are planar, 2-dimensional sheets as a consequence of the hexagonal, chicken wire-like, arrangements of carbon atoms. The new form of carbon just reported, however, is wildly distorted from planarity as a consequence of the presence of five 7-membered rings and one 5-membered ring embedded in the hexagonal lattice of carbon atoms. Odd-membered-ring defects such as these not only distort the sheets of atoms away from planarity, they also alter the physical, optical, and electronic properties of the material.

The new grossly warped nanographene is dramatically more soluble than a planar nanographene of comparable size and the two differ significantly in colour, as well. Electrochemical measurements revealed that the planar and the warped nanographenes are equally easily oxidised, but the warped nanographene is more difficult to reduce.

SOURCE OF COSMIC RAYS DISCOVERED

Cosmic rays were discovered more than 100 years ago, but their origin had remained a mystery till recently. Cosmic rays are mostly extremely energetic pieces of atoms: protons, electrons, and atomic nuclei which have had all of the surrounding electrons stripped during their high-speed (almost the speed of light) passage through the Milky Way galaxy. About 90 per cent of them are protons. During their journey across the galaxy, the electrically charged particles are deflected by magnetic fields. This scrambles their paths so much that it is no longer possible to point back to their sources in the galaxy. So the source of cosmic rays can be determined only by indirect means. A new study by an international team of more than 160 researchers using observations from NASA's Fermi Gamma-ray Space Telescope now provides the first clear-cut evidence of production of cosmic rays by the expanding debris of exploded stars. This discovery is considered a major step toward understanding the origin of cosmic rays.

After analysing four years of data, the Fermi scientists found a distinguishable feature in the gamma-ray emission of both supernova remnants. They detected the characteristic pion-decay feature in the gamma-ray spectra of the two supernova remnants, IC443 and W44, with the Fermi Large Area Telescope, which provided direct evidence that cosmic-ray protons are indeed accelerated by supernova shockwaves.

Researchers now have conclusive proof that supernova remnants, long the prime suspects, really do accelerate cosmic rays to incredible speeds. In other words, supernovas are indeed the source of cosmic rays.

OPTICAL VORTICES

In a breakthrough, scientists, including one of Indian-origin, have devised a new fibre optic technology that promises to increase bandwidth dramatically that can easing Internet congestion and video streaming. The technology centres on doughnut-shaped laser light beams called optical vortices, in which the light twists like a tornado as it moves along the beam path, rather than in a straight line.

Widely studied in molecular biology, atomic physics and quantum optics, optical vortices (also known as orbital angular momentum, or OAM, beams) were thought to be unstable in fibre, until Boston University Engineering Professor Siddharth Ramachandran designed an optical fibre that can propagate them. In the paper in journal Science, he and Alan Willner of University of Southern California, demonstrated the stability of the beams in optical fibre and also their potential to boost Internet bandwidth.

In experiments in the study, researchers created an OAM fibre with four modes (an optical fibre typically has two), and showed that for each OAM mode, they could send data through a one-kilometre fibre in 10 different colours, resulting in a transmission capacity of 1.6 terabits (10^{12} bits) per second.

DRIVERLESS CAR

A driverless car is also known as an autonomous car, or a robotic car. It is an autonomous vehicle all the capabilities of capabilities of a traditional car but needs no driver to drive it. It is equipped with instruments capable of sensing its environment and navigating without human input. Robotic cars exist mainly as prototypes and demonstration systems, but are likely to become more widespread in the near future.

Driverless cars are guided by a system of sensors and cameras and are seen as potentially safer and more efficient than regular vehicles. They sense their surroundings with such techniques as radar, lidar (light detection and ranging), GPS, and computer vision. Advanced control systems interpret sensory information to identify appropriate navigation paths, as well as obstacles and relevant signage. Some driverless cars update their maps based on sensory input, allowing the vehicles to keep track of their position even when conditions change or when they enter uncharted environments.

Driverless cars will be tested on public roads by the end of 2013, says the UK government. So far, UK trials of the autonomous vehicles have taken place only on private land. For now, the cars will be driven on lightly-used rural and suburban roads in a "semi-autonomous" mode which gives human passengers the choice to intervene.

HUBBLE DETERMINES COLOUR OF A DISTANT EXOPLANET

Astronomers have used the Hubble Space Telescope to determine the true colour of the distant world; the first time such a feat has been achieved for a planet that circles a star other than the Sun. The planet is HD 189733b, and orbits a star 63 light-years away and is cobalt blue in colour. If seen directly, this planet would look like a deep blue dot, reminiscent of Earth's colour as seen from space. Although the planet resembles Earth in terms of colour, it is not an Earth-like world. On this turbulent alien world, the daytime temperature is nearly 1,100 degrees Celsius, and it possibly rains glass, accompanied by winds blowing at more than 7,200 km per hour.

The cobalt blue colour comes not from the reflection of a tropical ocean as it does on Earth, but rather a hazy, blow-torched atmosphere containing high clouds laced with silicate particles. Silicates condensing in the heat could form very small drops of glass that scatter blue light more than red light. HD 189733b is among a bizarre class of planets called 'hot Jupiters', which orbit precariously close to their parent stars. HD 189733b was discovered in 2005. It is only 4.7 million kilometres from its parent star, so close that it is gravitationally locked. One side always faces the star and the other side is always dark.

HINTS OF DARK MATTER FOUND

Physicists have puzzled over the nature of dark matter since the 1930s, and billions of dollars have been spent building experiments to track it down. One possible candidate for dark matter are theoretical particles known as 'weakly interacting massive particles', or WIMPs, which are being searched for by an experiment called the Cryogenic Dark Matter Search, or CDMS experiment in an underground lab in USA. The CDMS experiment is designed to pick up the signal of WIMPs as Earth passes through the Milky Way galaxy's sea of dark matter.
The CDMS consists of a network of silicon and germanium crystals cooled to near absolute zero. Scientists working with the CDMS experiment reported on 13 April 2013 that they have detected three potential signatures of exotic dark matter particles hidden in the readings recorded with silicon detectors. The findings were presented at the American Physical Society meeting in Denver, USA. The interactions seen by the CDMS team point to the existence of WIMPs with a best-guess mass of 8.6 billion electron volts, which would be about nine times as massive as the proton. The scientists say there is a 99.8 per cent chance that their results reflect a real phenomenon rather than an experimental error. If the results are confirmed by further experiments that would point to the existence of WIMPs that could help account for the 27 per cent of the Universe that is thought to consist of dark matter.

Kudankulam Nuclear Power Plant

The reactors at the Kudankulam Nuclear Power Plant are PWRs which use 4% enriched uranium-235 as fuel and ordinary water both as coolant and moderator. Each of the two VVER-1000 reactors has a generating capacity of 1000 MW, making them the largest nuclear power reactors in the country. (VVER stands for Vodo-Vodyanoi Energetichesky Reactor.)

During the recent agitation against the Kudankulam plant, which has been continuing for months, thousands of fishermen were mobilised to stop loading of fuel in the reactors. However, contrary to some misguided propaganda, there is no reason to have doubts about the safety of the reactors at the Kudankulam atomic power plant in Tamil Nadu. The VVER-1000 reactors have some advanced safety features like passive heat removal system, double containment, core catcher, and hydrogen re-combiner instead of conventional systems. A core catcher is a device provided to catch the molten core material of a nuclear reactor in case of a nuclear meltdown and prevent it from escaping the containment building. Incidentally, Russian VVERs are inherently safer designs than the RBMK reactors that exploded in Chernobyl.

The design of the reactors at Kudankulam has been evolved from serial design of VVER-1000 reactors, of which 15 units are under operation in more than ten countries around the world for the last 25 years. It may be pointed out in this context that the Russians have credited and acknowledged on several occasions the improvements in their reactors which were recommended by Indian experts. When negotiations were going on for the Kudankulam plant, the Indian experts did not agree to adopt the then current VVER-1000-megawatt reactor model V-320 and suggested improvements for the reactors to be constructed at Kudankulam. The Russians agreed to the Indian suggestions and the Russian designers worked upon the agreed specification to produce the advanced VVER-1000 'Generation 3+' model named V-396. The Kudankulam reactors are an advanced version of the same.

The VVER design adopted for Kudankulam has in additional many additional unique safety features, which include (i) Negative power coefficient, wherein any increase in reactor power is self-terminating, and (ii) Negative void coefficient, which will cause the reactor to shut down if there is loss of water. Design safety of the plant incorporates defence-in-depth concept, which comprises a five-barrier system to prevent release of radioactivity in the environment. The five-barrier system includes: (i) Fuel matrix; (ii) Fuel cladding; (iii) Main circulation circuit; and (iv) and (v) Inner and Outer containment shields. Five tiers of engineered features and administrative measures are provided to protect these barriers.

Each reactor also incorporates active safety systems, which include: Emergency reactor shutdown; Emergency boron injection; Containment spray; High-pressure safety injection; Primary system emergency and planned cool down and fuel pool cooling; and Primary circuit shut-down cooling systems.

The Kudankulam reactors and buildings are designed to withstand external effects involving earthquake, tsunami/storm, tidal waves, cyclones, shock waves, fire, and aircraft impact on main buildings.

As compared to the design basis flood level of 5.44 metres, the Kudankulam reactors are located more than 8.7 metres above mean sea level at the site. Safety diesel generator sets are located at a height of 9.3 metres above mean sea level. As a further protection, the supplementary control room and the four diesel generator-safety train rooms are provided with water-tight doors to protect them against flooding.

The Kudankulam site is located far off (about 1,500 km) from any geologic fault that may cause tsunamis. So, if there is a tsunami, it would take time and lose its energy by the time it reaches Kudankulam site. In contrast, the source of the tsunami that hit Fukushima in March 2011 was only 130 km away.

It is worth remembering that the nuclear power industry has always been aware of the potential hazards of the radioactive nature of the nuclear fuel and nuclear waste in nuclear power generation. For this reason, extreme care is taken in the design and operation of nuclear power plants to minimise the likelihood of accidents, and avoid major human consequences when they occur. As a precautionary measure, Environmental Survey Laboratories are set up before any major nuclear facility is established and these laboratories continue to monitor the surrounding environment throughout the period of existence of the facility. Stringent safety provisions are made in nuclear reactors to avoid any accident. Safety is ensured in the design of plants and in their operation. Nuclear reactor safety includes control of reactor (control rods), removal of heat generated in the core (coolant), and containing the radioactivity (containment shield).

The design of the reactor also includes multiple back-up components, independent systems (two or more systems performing the same function in parallel), monitoring of instrumentation and the prevention of a failure of one type of equipment affecting any other. By regulation, the design of the nuclear reactor must include provisions for human error and equipment failure. Nuclear plants use a system with multiple safety components, each with back-up and design to accommodate human error.

In order to ensure availability of trained manpower to safely run the country's nuclear power plants, the Department of Atomic Energy (DAE) has established a number of new institutes and educational programmes to augment its on-going, well established nuclear training programmes.

The Nuclear Power Corporation of India Limited (NPCIL), the country's sole constructor and operator of nuclear power plants, also has its own nuclear training centres close to nuclear power plant sites. The majority of training for non-graduate technical staff as well as for new engineering graduates and other technical staff is provided through these centres. More recently, some Indian universities too have begun courses in nuclear engineering. In 2008, the Jawaharlal Nehru Technological University started a two-year master's course in nuclear engineering for candidates holding engineering degrees in mechanical, chemical, civil or metallurgy fields.

Printing in 3 dimensions

3D printing is a process of making a three-dimensional solid object of virtually any shape from a digital model. 3D printing is achieved using an additive process, where successive layers of material are laid down in different shapes. 3D printing is considered distinct from traditional machining techniques, which mostly rely on the removal of material by methods such as cutting or drilling (subtractive processes).

A materials printer usually performs 3D printing processes using digital technology. The 3D printing technology is used for both prototyping and distributed manufacturing with applications in architecture, construction, industrial design, automotive, aerospace, military, engineering, civil engineering, dental and medical industries, biotech (human tissue replacement), fashion, footwear, jewellery, eyewear, education, geographic information systems, food, and many other fields. To perform a print, the machine reads the design from an .stl or stereolithography file and lays down successive layers of liquid or powder material to build the model from a series of cross sections. These layers, which correspond to the virtual cross sections from the CAD model, are joined or automatically fused to create the final shape. The primary advantage of this technique is its ability to create almost any shape or geometric feature. Traditional techniques like injection moulding can be less expensive for manufacturing polymer products in high quantities, but additive manufacturing can be faster, more flexible and less expensive when producing relatively small quantities of parts. 3D printers give designers and concept development teams the ability to produce parts and concept models using a desktop size printer.

Production of guns by 3D printing was in the news recently. An American group has been steadily working its way up the 3D printed firearms evolutionary ladder, making parts for guns, then guns themselves, and then firing a gun. However, according to reports, the 3D printed gun made of plastic costs a small fortune to produce and requires a highly specialised and even more expensive 3D printer to produce. Moreover, it is fragile and liable to self-destruction after a few rounds are fired.

A Dutch firm is currently attempting to build the world's first 3D-printed house. Based in Amsterdam, the builders are using a six-metre-tall, purpose-built printer to print components of the house from plastic. Each part of the property is initially printed in a scale of 1:20 on a smaller printer, before being printed in its final size, layer by layer, by the main printer. The production

process has already begun – developers aim to have the entire front façade of the canal house constructed before the end of the year, along with the building's internal lobby. As development continues, a 3D-printed kitchen, study, storage room and guestroom are to be added to the building.

A for creating biological shapes, a 3D printer works like an injet printer, but here the cartridge, which usually holds ink, is filled with living human cells and inplace of paper in the tray, a specialised gel sits ready to catch the finished product. A computer-programmed script instructs the printer to deposit the cells in layers upon layers, slowly forming a vaguely biological shape.

Recently, scientists, including an Indian-origin researcher, have created a 3D printed 'bionic' ear that can "hear" radio frequencies far beyond the range of normal human capability. Using off-the-shelf printing tools, the scientists at Princeton University explored 3D printing of cells and nanoparticles followed by cell culture to combine a small coil antenna with cartilage, creating a 'bionic' ear. While the bionic ear isn't designed to replace our own ears, it is a successful proof of concept of the combining of 3D printed living, biological materials with electronics. Future versions of the bionic ear could help restore hearing, but its other potential applications are far more interesting. The research could lead to synthetic replacements for actual human functions, and to a sort of electronic sixth sense.

Scientists are also experimenting with bioprinted liver tissue prototypes. The vision is that within decades, scientists will be able to take a biopsy of the liver of someone needing a replacement and then print a new 3D version.

Glaciers around Mount Everest retreating fast

According to a survey of scientific literature produced over the past two decades that claims to be the most comprehensive of its kind, an overwhelming majority of scientists agree that humans have caused global warming. And one of the major consequences of global warming is loss of snow and ice cover in the Polar Regions and on the world's mountains. A glaring example is the extensive retreat of glaciers in the Mount Everest region in the Himalayas. A recent study has shown that glaciers in the Mount Everest region have shrunk by 13 per cent in the last 50 years and the snowline has shifted upward by 180 metres. The study was conducted by a research team led by Sudeep Thakuri, who led the team as part of his PhD graduate studies at the University of Milan in Italy. The findings were presented at the Meeting of the Americas – a scientific conference organised and co-sponsored by the American Geophysical Union, held in Cancun, Mexico from 14 to 17 May 2013. The researchers suspect that the decline of snow and ice in the Everest region is from human-generated greenhouse gases altering global climate.

For the study, Thakuri and his team determined the extent of glacial change on Everest and the surrounding 1,148 square kilometres Sagarmatha National Park by compiling satellite imagery and topographic maps and reconstructing the glacial history. Their statistical analysis shows that there is a significant increase in the rate at which majority of the glaciers in the national park are

retreating. According to the researchers, glaciers smaller than one square kilometre in area are disappearing the fastest and have experienced a 43 per cent decrease in surface area since the 1960s.

To evaluate the temperature and precipitation patterns in the area, Thakuri and his colleagues analysed hydro-meteorological data from the Nepal Climate Observatory stations and Nepal's Department of Hydrology and Meteorology and found that there has been a 0.6 degree Celsius increase in temperature and 100 millimetre decrease in precipitation during the pre-monsoon and winter months in the Everest region since 1992.

For India, this is worrying news because the Himalayan glaciers and ice caps are considered a water tower for much of Asia, and especially India, since they store and supply water downstream during the dry season. A large part of the Indian population, especially in the Indo-Gangetic Plain is dependent on the melt water for agriculture, drinking, and power generation during the summer months.

Economic and other losses due to extreme weather events

The year 2012 set major records in climate extremes. It was the hottest year in US history and second wettest one in the UK. Data from 2011 and 2010 show similar extremes. But not only is climate change getting worse, it is also getting costlier. A report by United Nations International Strategy for Disaster Reduction (UNISDR) reveals 2012 is the third consecutive year to suffer economic losses of over $100 billion due to extreme weather events.

Developed nations tend to accrue large economic losses in the face of a natural disaster as they have more assets and infrastructure. Most developing countries, however, rank far higher in terms of number of disasters that hit each year, number of deaths and percentage of population affected, but do not show large financial losses owing to negligible number of insured assets.

Asia was the worst affected in terms of casualties due to natural disasters; 65 per cent of those killed in 2012 were Asians. Most were victims of floods and droughts, which were responsible for nearly 80 per cent of all deaths. But as they occurred in poorer countries, the economic losses are low.

Significantly, economic as well as environmental impacts of climate change are not felt evenly and those who pollute the most might not suffer the most. This raises the question of liability and compensation. At the climate change meet in Doha (CoP-19), under the United Nations Framework Convention on Climate Change (UNFCCC) in November 2012, countries fought a bitter battle to answer just this. In what was considered a mighty win for developing nations, CoP-19 agreed upon "institutional arrangements, such as an international mechanism," to address loss and damage due to climate change in particularly vulnerable developing countries. The agreement was very significant in accepting the concept of loss and damage as going beyond adaptation. It recognises that there are situations where developing countries will not be able to have any adaptation response but will suffer loss and damage like loss of land, crops, etc.

However, UNFCCC still does not have a working definition for loss and damage. Many parties are concerned that losses could be narrowed down to economic loss. What about the non-economic losses, they ask? Who would be liable for the loss of cultural identity and indigenous knowledge when an island goes down or when an area turns to desert? While this makes reaching at a solution more challenging, it is crucial to the issue.

Experts, however, believe that even if a consensus is reached on loss and damage, there's a pressing need for developed nations to mitigate emissions and check further environmental damage.

India's new weather satellite

INSAT-3D is a meteorological data relay and satellite-aided search and rescue satellite designed and developed by the Indian Space Research Organisation which was launched using an Ariane 5 launch vehicle from French Guiana on 26 July 2013. INSAT-3D supplements the decade-old and fading Kalpana-1 and INSAT-3A with four sophisticated payloads and is expected to sharpen weather observation and forecasting and also enhance land and sea surface monitoring over the sub-continent and the Indian Ocean region. The primary objective of the mission is "to provide an operational, environmental and storm warning system to protect life and property and also to monitor Earth's surface and carryout oceanic observations and also provide data dissemination capabilities".

The satellite is equipped with a six-channel imager that takes weather pictures of the Earth with better resolution than its predecessors. Its 19-channel sounder is the first such over the region and gives layered vertical profiles of temperature, humidity and integrated ozone.

The data relay transponder on-board the satellite will be used for receiving meteorological, hydrological and oceanographic data from remote, uninhabited locations over the coverage area from unmanned data collection platforms (DCPs) like automatic weather station, automatic rain gauge and agro met stations. India Meteorological Department and ISRO have established more than 1,800 DCPs for round-the-clock data gathering and relay.

INSAT-3D is equipped with a search and rescue payload that picks up and relays alert signals originating from the distress beacons of maritime, aviation and land based users and relays them to the mission control centre to facilitate speedy search and rescue operations. The major users of Satellite Aided Search and Rescue service in India are the Indian Coast Guard, Airports Authority of India, Directorate General of Shipping, Defence Services, and fishermen. The Indian service region includes a large part of the Indian Ocean region covering India, Bangladesh, Bhutan, Maldives, Nepal, Seychelles, Sri Lanka and Tanzania for rendering distress alert services.

Lithium-sulphur batteries are safer and longer-lasting

Today we have ultra-fast means of telecommunication and versatile portable electronic devices that bring the world to our fingertips anywhere and at any time. But no matter how high-tech these gadgets are, they still need electric power provided by the humble battery for sustenance. Batteries have evolved much over the years. Lithium-ion batteries have replaced the basic carbon-zinc and alkaline ones, which are still used in flashlights and TV remotes. As electronic gadgets become increasingly high-tech, scientists scramble to create batteries that are small, inexpensive and long lasting, and lithium-ion batteries appear to fit in ideally. But recent incidents involving fire risk in lithium-ion batteries in Boeing Dreamliner aircraft had raised doubts about the safety of lithium-ion batteries. Although the issue has been resolved, scientists are looking for better and safer alternatives.

Recently, a team led by Chengdu Liang at the Oak Ridge National Laboratory, USA has designed and tested an all-solid lithium-sulphur battery with approximately four times the energy density of conventional lithium-ion technologies that power today's electronics. Using the new technology the researchers were able to maintain a capacity of 1200 milliamp-hours per gram (mAh/g) after 300 charge-discharge cycles at 60 degrees Celsius. For comparison, a traditional lithium-ion battery cathode has an average capacity between 140-170 mAh/g. The new battery design, which uses abundant low-cost elemental sulphur, also addresses flammability concerns experienced by other chemistries.

The new batteries would also be more environmental friendly compared to current designs. According to the researchers, "not only does sulphur store much more energy than the transition metal compounds used in lithium-ion battery cathodes, but a lithium-sulphur device could help recycle a waste product into a useful technology".

World's Fastest Electrical Switch

Electrical engineers at the United States Department of Energy's National Accelerator Laboratory have built the world's fastest electrical switch - the one that takes just a trillionth of a second to operate. The research team says that this could lead to breakthrough innovations in the transistors designs making them faster, more powerful and reliable with potential use if future computers. Scientists using SLAC's Linac Coherent Light Source (LCLS) X-ray laser found that it takes only 1 trillionth of a second to flip the on-off electrical switch in samples of magnetite, which is thousands of times faster than what the current generation of transistors can achieve.

The researchers say that the breakthrough reveals for the first time the 'speed limit' for electrical switching using magnetite – a naturally magnetic material. The experiment showed the researchers how the electronic structure of the sample they studied rearranged into non-conducting islands. These islands were surrounded by electrically conducting regions which formed very quickly after the laser pulse struck the sample. The experiment also showed the

researchers how both conducting and non-conducting states co-exist and can create electrical pathways to be used in the next generation of transistors.

The Kepler spacraft

The Kepler spacecraft, launched by NASA in 2009 to look for Earth-like planets in a narrow region of the sky, was finally put out of action by the loss of a second gyroscope-like "reaction-wheel"– a mechanism that helped accurately point the craft at a certain star. It needed at least three out of its four original wheels to continue collecting data, and after May 2013 it was left with only two.

The Kepler spacecraft was NASA's extra-solar planet hunter. The first of its kind, the spacecraft successfully confirmed the existence of 136 planets around other stars before it became inoperative.

The way it found those planets was relatively simple: It monitored a rich star field for the dimming of starlight when a planet would orbit in front of its respective Sun – known as the technique of 'transit'. Specifically, the Kepler spacecraft would read the light from stars near the constellations of Cygnus and Lyra – it closely monitored over 100,000 stars simultaneously during its tenure. Not only did Kepler confirm hundreds of planets outside our own solar system – so called "exoplanets" – it collected evidence suggestive of thousands of planets not yet confirmed. According to NASA, with the help of the Kepler spacecraft astronomers have discovered 2,740 planet candidates orbiting 2,036 other suns in a search for Earth-sized worlds.

Though the spacecraft can no longer be used to search for exoplanets using the transit technique, it can still be used for collecting information about extra-solar planets by using yet another technique known as 'microlensing'. This method looks for magnification of a star's light when two stars align themselves with respect to the telescope. Any star with orbiting planets could even double the brightness of the other star's light. Even as Kepler's fate is being decided, there can be no denying that it has revolutionised our understanding of stars and earth-twins.

Micro Pulse Lidar

Micro pulse lidar (MPL) is a versatile tool for atmospheric observations and weather forecasting. It is a sophisticated laser remote sensing system that provides continuous, unattended monitoring of the profiles and optical properties of clouds and aerosols in the atmosphere. Based on the same principle as radar, a micro pulse lidar transmits green laser pulses that scatter off particles in the atmosphere. The laser pulses go through atmospheric layers that include air molecules, aerosols (pollutants) and clouds. Return pulses give information on atmospheric composition. The micro pulse lidar lab collects the data and measures the intensity of backscattered pulses using photon-counting detectors, and transforms the signal into atmospheric information in real time.

Recently an indigenously designed micro pulse lidar has been installed in the second campus of Indian Institute of Technology in Challakere in Chitradurga District, Karnataka. The first of its kind in India, it will be used to improve weather forecasts. The data collected from the laser beam can make an extensive study of the climate in areas within 200-plus km radius. According to scientists of IISc, the installation will be of great help in foretelling the nitty-gritties of capricious weather such as, whether it will be a cloudburst or heavy winds; how strong or weak the next monsoon will be; whether the mercury will soar higher next summer; or how cold next November will be? These are some of the questions that can be answered with more precision with help from data gathered by the micro pulse lidar.

Meteorologists can use a micro pulse lidar to improve the quality of weather and air quality forecasts. Atmospheric and environmental researchers and regulators can use it to improve models and emission estimates by determining the extent of manmade and natural aerosols and measuring the height of the Micro pulse lidar can also be used by airports and air traffic controllers to optimise aviation safety through enhanced cloud and volcanic ash profiling

In addition to improving weather models and forecasts, micro pulse lidar cloud profiles can also provide detailed information to air traffic control for pilots near airports and thereby enhance aviation safety.

Google Glass

Essentially, Google Glass is a camera, display, touchpad, battery and microphone built into spectacle frames so that you can perch a display in your field of vision, film, take pictures, search and translate on the go. Google Glasses look like a pair of normal eyeglasses, but the lenses of the glasses are an interactive, smartphone-like display, with natural language voice command support as well as Bluetooth and Wi-Fi connectivity. Google Glass is powered by the Android mobile operating system and is expected to offer compatibility with both Android-powered mobile devices and Apple iOS-powered devices.

Google Glass uses display technology instead to put data in front (or at least, to the upper right) of your vision courtesy of a prism screen. This is designed to be easily seen without obstructing your view. According to Google the display is "the equivalent of a 25-inch high definition screen from eight feet away".

The embedded camera obviously does not need a viewfinder because it is simply recording a first-person perspective, allowing the wearer to take snaps or footage of what he or she is actually seeing. Any function that requires the wearer to look at a screen could be put in front of him or her.

All data is controlled with a microphone and touchpad on one arm of the frame and one can select whatever one wants to do with a brief gesture or by talking to the device, and Google Glass will interpret the commands.

Low-cost microsatellites

Imaging from a satellite is a standard technique of remote sensing for natural resources and cartography (map making). Satellites offer a unique vantage point that can reveal things on ground that no other imaging technology can offer. But commercial satellites used for remote sensing are large and expensive, costing millions of rupees. Very soon, inexpensive, low-orbiting microsatellites will be sending back frequent, low-cost snapshots of most of Earth's populated regions from space. Commercial companies, universities, space research agencies such as NASA and ESA, are all in the development of a new spacecraft generation called microsatellites.

The new satellites, some weighing even less than 10 kg, built with some of the same off-the-shelf miniaturised technology that has made smartphones and laptops so powerful, will be far less expensive than their larger counterparts. Moreover, since putting a satellite in orbit is a function of its size, these new satellites can be put into orbit at a much lower cost. The companies operating such satellites do not have to spend millions of rupees for a rocket to get them into space. Instead, they can hitch a ride as a secondary payload on a rocket already making the trip.

The view from high up is rich in untapped data, and the new satellite services may find many customers. Insurance companies, for example, could use the satellites' "before" and "after" views to monitor insured property and validate claims after a disaster. Businesses that update online maps for geologists, city planners or disaster relief officials could be customers, too. The images could also be used to monitor problems like deforestation, melting icecaps and overfishing. In addition, food companies and commodities traders could use the images to keep track of crops and agricultural yields all over the planet. And these service could be had at much less cost than available from commercial remote sensing satellites today.

At the same time, however, the frequency with which images can be updated could raise privacy questions. The images are also likely to be viewed as the latest mixed blessing by people already apprehensive of Big Brother-like surveillance in their lives.

Sun Changing Its Magnetic Polarity

The Sun's magnetic field changes polarity approximately every 11 years during the peak of each solar cycle as the Sun's inner dynamo reorganises itself. This next reversal which will occur in the coming three to four months will be only the fourth observed since tracking began in 1976 and will mark the midpoint of Solar Cycle 24. The flipping of the Sun's magnetic field marks the peak of the star's 11-year solar cycle and the halfway point in the Sun's "solar maximum" – the peak of its solar weather cycle.

During a magnetic field reversal, the Sun's polar magnetic fields weaken, go to zero and then emerge again with the opposite polarity. This is a regular part of the solar cycle. The magnetic pole reversal is likely to have ripple effects throughout the solar system. It will lead to more geomagnetic storms but will also provide extra shielding from dangerous cosmic rays which are produced by supernova explosions and zip through the universe at nearly the speed of light. They can harm satellites and astronauts in space, and the changes produced during Sun's pole reversal better protects the planet from these particles.

According to experts, the current solar maximum is the weakest in 100 years and there have been fewer sunspots seen than is usual during a solar maximum. Usually, at the height of a solar cycle, sunspot activity increases and there are increased incidence of solar flares and coronal mass ejections. But the number of sunspots seen during the current solar maximum is far less than in the number of sunspots observed during maximums of previous cycles.

Lunar Atmosphere and Dust Environment Explorer (LADEE)

For nearly a half century, planetary scientists have been puzzled by tenuous "clouds" of dust hovering over the lunar surface. With observations from a soon-to-be-launched spacecraft, they finally hope to understand just what's going on.

First seen by the Surveyor 7 lander in 1968 and later by Apollo astronauts, clouds of fine dust sometimes levitate above the lunar surface. Since these localised "flurries" occur at dawn and dusk, researchers have speculated that some kind of static charging might be involved. But the true cause remains unknown.

To help unravel this longstanding mystery, NASA's Lunar Atmosphere and Dust Environment Explorer (LADEE) was launched towards Moon on 6 September. 30 days after leaving Earth, a final rocket blast will nudge LADEE into a looping retrograde orbit over the lunar equator. Eventually that will be trimmed first to a circular altitude of about 250 km, and then to an even lower circuit that at times skims no more than 20 km from the lunar surface.

LADEE will use its ultraviolet spectrometer and neutral mass spectrometer to analyse the ultra-tenuous wisps of gas hovering over the Moon. This exosphere probably arises due to the continual bombardment of the lunar surface and is likely rich in helium (derived from solar-wind ions trapped on grain surfaces) and argon (produced by the decay of radioactive potassium in the lunar crust).

Meanwhile, the Lunar Dust Experiment will sweep up high-flying motes as small as 2 microns across. After striking the instrument's hemispherical target, they'll vaporize into tiny clouds of ions and electrons that reveal the particles' mass and composition.

The $280-million spacecraft is expected to spend about 100 days exploring moon's atmosphere and the role of dust in the lunar sky before running out of fuel and crashing into the Moon's surface.

Indian scientists find endogenous water on the Moon

It was the Indian Moon probe Chandrayaan-1 that found evidence of water on Moon for the first time in 2009. But the source of the lunar water was not known. Now a team of Indian scientists from the Space Applications Centre (SAC) in Ahmedabad, led by Satadru Bhattacharya, has found evidence of water of volcanic origin — water that has originated from deep within the Moon's interior — rather than water-bearing igneous surface lunar material detected hitherto by different lunar missions including Chandrayaan-1. The finding is based on an analysis of high-resolution spectral data of the Compton-Belkovich Volcanic Complex region on the far side of the Moon obtained by the NASA instrument Moon Minerology Mapper (M3), which was sent aboard the Indian lunar mission Chandrayaan-1.

Thus far scientists had believed lunar rocks were "bone dry" and that any water detected in lunar samples was either due to contamination from the Earth or produced by solar wind and other exogenous extra-lunar sources. Significantly, the concentration of the water detected by Indian researchers — 0.55 per cent by weight — is the highest ever found on the Moon. The presence of such endogenous water could call for revision of models of Moon's origin