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OCEAN DEVELOPMENT

The oceans and their inter-connecting seas form a continuous territory that covers about three-fourths of the earth's surface. Within these liquid expanses, there are seemingly inexhaustible sources of food, minerals and energy. The development of marine resources such as fish, petroleum, sand and gravel, desalinated water aquaculture, phosphorus and manganese nodules, placer minerals, extracted chemicals, fish protein concentrates, etc. is already possible with the available technology and major countries of the world, recognizing the potential economic importance of marine resources have already organized their efforts in this area, and India, too, is making a beginning.

A proper consideration of marine resources should begin with an understanding of the features characteristics of the deep ocean. The physiographic features consist mainly of a continental shelf extending from the beach to a distance of up to 1300 km with outer depths of 50 to 500 metres, a continental slope slanting gently downwards from the shelf to the ocean depths of 3 to 5 kilometres at a slope of about 5°.

The chemical features of the ocean consist of a complex solution of dissolved chemicals with surprisingly uniform content of approximately 40 chemicals. A vastly more dilute and less understood solution of trace elements and organic constituents supports and permits life to exist within the sea.

The biological features of the sea consist mainly of over 10,000 known species of single-celled plants called Phytoplanktons that support all marine life through photosynthesis, an almost equally large variety of tiny animals called Zooplanktons, an enormous variety of invertebrates, fishes, mammals (e.g. whales, seals, etc.) that depend on the atmosphere for oxygen and include some of the most intelligent animals in the whole animal kingdom.

The major focus of marine activity today, tends to lie in mankind's search for food and energy. The sea is an excellent source for a most critical element of the human diet - animal protein. Some 15 per cent of the world's supply of animal protein comes from fisheries and it has been calculated that the potential yield, given the proper technology is between 8 to 34 times the world's requirements.

The Indian Ocean produces only 2.4 million tonnes of fish, which amount to only four per cent of the total world production. However, the potential fish catch from this area is estimated to be at least four to five times more. Water which can sustain prawn and tuna have not been fully exploited while only minimal attention has been paid to coastal aquaculture i.e. the culture and raising of oysters, clams and mussels.

The success of oceanic fishing depends on how well we determine the location of the fish shoals and on the level of sophistication of available marine technology in the country. Locating, tracking and identifying fish shoals involve two major steps—

1. Searching for the general area in which commercial concentrations are expected.
2. Localising and detecting the precise position of the fish. Of even more significance in the exploitation of marine resources is the possibility of finding oil and gas offshore in large quantities. It has been established that approximately 20 per cent of the world's reserves of oil lie offshore. In India the major potential offshore areas for oil and gas are the Gulf of Cambay, Bombay High, the Indo-Sri Lanka trough, the Bay of Bengal, the Andaman & Nicobar Islands and Krishna Godavari (KG) Basin.

In India among other physical resources, heavy mineral rich beach sands containing Monazite and Ilmenite have been found on the Kerala, Tamil Nadu, Maharashtra, Andhra Pradesh and Orissa coasts. The offshore

occurrence of calcareous deposits suitable for the chemical and cement industries have been reported from bottom samples off the Andaman and Nicobar Islands, Saurashtra, Kerala and Lakshadweep. These deposits, which represent the remains of calcareous organism such as coal are also expected to occur in many more areas all around the Indian peninsula. Phosphate nodules and Barium concentrations have been recorded off the west coast of India and Lakshadweep while chromite has been found in the sea floor rifts of Indian Ocean. Efforts to survey the extent of these resources have however been few and far between and in the absence of technical capabilities there have been no systematic efforts to exploit them.

A large number of organizations have been working in the field of ocean science and engineering for marine resource exploitation in India. The Geological Survey of India is responsible for all investigations pertaining to geological sciences excluding the exploration and exploitation of oil and natural gas, which is under the domain of the Oil and Natural Gas Commission. The Atomic Energy Commission conducts studies on the deposition and replenishment of minerals in the coastal regions as well as on the presence and behaviour of radioactive elements. The Tata Institute of Fundamental Research, Mumbai, has carried out research in chemical oceanography. While the Meteorological Department has done some work in marine meteorological studies. The National Institute of Oceanography created in 1966, is responsible for research on the basic aspects of physical, chemical, geological and biological oceanography and also for handling oceanographic data. The Naval Hydrographic office conducts hydrographic studies.

Some state governments have their own geological departments to carry out geological surveys and some universities like those of Andhra and Kerala are also involved in various coastal studies pertaining to marine geology and biology.

All these organizations and their research efforts were coordinated by the Indian National Committee of Oceanic Research (INCOR) established by the Government of India in 1960 to draw up a programme for India's participation in the International Indian Ocean Expedition during 1962-65. The task has since been taken over by the Department of Science and Technology, which visualizes the creation of a separate Ocean Science and Technology Commission to coordinate the Indian efforts.

BIOLOGICAL RESOURCES

Phytoplanktons are the principal plants in the ocean and are the base of the food chain. The distribution of zooplankton which feed on the phytoplankton is world's major fishing areas. Oceans have become major source of food and are more likely to become so in future. Because of its sheer size, oceans will have a larger food potential. Again due to increased population, little option is left for agricultural extension on land and henceforth the human population will be under compulsion to move towards the ocean to satisfy its demands. Ocean food resources are nutritionally advantageous or better source of amino acids in correct proportion, better source of vitamin-B_{12}, low in cholesterol and fat, high in polyunsaturated fats and essential fatty acids.

India is a littoral state with a vast coastline of about 6000 km and the Exclusive Economic Zone (EEZ) of about 2.02 million sq km. About 50 per cent of sustainable fishing zone of India's EEZ lies in inshore zone of less than 50 metres depth. India ranks 8th in the annual fish catch in the world. In India, the marine fish accounts for about 56 per cent of the total national fish catch. However, the annual potential in India is about 10 million tonnes. Intensive prawn farming has been developed at Nellore in Andhra Pradesh and improved shrimps farming in Andaman and Nicobar.

FRESH-WATER RESOURCES

Oceans, ice-caps and glaciers constitute about 97.2% and 2.15% of world's water supply respectively. Fresh water extracted from the sea is one of the most valuable resources, especially for the countries where land water availability is very difficult and costly. Icebergs, another source of fresh water, would be found by some mechanism to the areas where water is needed like Saudi Arabia, California, Australia, etc.

Ocean water is neither fit for human consumption nor for agricultural purposes. But, it can be converted into fresh water through

desalination. The important methods of desalination are:

(i) **Solar Still:** In this process, the sea water is boiled by concentrating solar heat and then condensing the steam as fresh water. In India, in Avnea village of Gujarat, such a plant has been established with the capacity of 5000 litres per day.

(ii) **Electrodialysis:** In this method, iron-reflective membrane is used for the desalination of brackish water.

(iii) **Flash Distillation:** Here, the heated saline water is passed through a series of chambers. In each section, vapour is released and collected, and then condensed.

(iv) **Reverse Osmosis:** In this process, suitable osmotic membranes are used which rejects salt and allow water to pass through it when the sea water is put under high pressure.

However, there are some problems regarding the desalination processes. It is very costly and needs huge amount of energy. The desalination plants release significant amount of heat and pollutants. There would be problem of the disposal of vast amount of salt.

In India, Central Salt and Marine Chemical Research Institute (CSMCRI) at Bhavnagar (Gujarat) has done much in this sector. BHEL is manufacturing desalination plants of different sizes.

MINERAL RESOURCES

Oceans are the storehouse of valuable minerals in the world. Mineral resources, available in ocean, are of different kinds like energy resources (oil, gas, and coal), metallic minerals (manganese, iron, tin, etc.), chemicals (salt of sodium and chlorine and bromine, etc.), manganese nodules and polymetallic nodules and others (coral, limestone etc).

a) Chemicals: About 64 out of total 92 naturally occurring chemicals are dissolved in sea-water, although, only a few of them are commercially viable for extraction. Sodium and chlorine are most abundant, about 85% of the total dissolved salts are found in the seas. Magnesium and Bromine are other chemical elements.

b) Metals/Minerals: They include gold, silver, zinc, uranium, thorium, etc. It is claimed that metals can be hauled from the sea at 50-70% of the cost of launching as the sea ores are often highly concentrated. However, not all of them are so available and with the present status of technology they are costly to extract. On the basis of areas of availability, the mineral resources can be again divided in the following way:

- **On Continental Shelf and Slopes:** This zone is rich in zircon, monazite, magnetite, gold, diamond, platinum, phosphorite, sulphur, etc. Mud and sands found on the continental shelf are rich in copper, zinc, lead and calcium. Sand is a source of calcium carbonate. Phosphorite is found in the form of nodules containing about 30% phosphate. On the western coast of India, especially the Kerala coast, the sand of the sea coast possess about 90% of world's monazite reserve, which is the chief nuclear energy resource for the future. Along with magnetite, zircon and rutile are also found on the west coast of India and is viable for extraction.
- **Sub-surface Deposits:** The most important sub-surface deposits are mineral oil and gases and coal. At present, about 90% of the mineral value is taken from the sea. The mineral oil deposits are mostly found in the continental shelves. There are many structures, which work as a trap for petroleum and natural gas, such as, salt dome. Thick sediment deposit and relatively high concentration of organic matter suggest to the occurrence of petroleum. Submerged coal deposits are found in Japan, U.K and South Africa.
- **Deep Sea Deposits:** There are two main types of mineral deposits found on the deep sea bed which are economically viable. They are manganese nodules and metalliferous sediments of polymetallic sulphides.

c) Manganese Nodules: These nodules are most abundant in the deepest part of the ocean, very often in trenches. They are

hydrogenous pelagic deposits and found in large concentration in red clay. They mainly contain manganese, iron, nickel, copper, cobalt, lead and zinc. They are mainly spherical in shape from one to twenty cm in diameter. About 25% of the sea floor is expected to be covered by these deposits. In Indian Ocean, over 10 million sq. km. area, east of central Indian ridge has such potential. They are less expensive source of these metals. Again, they will be less polluting than mining on land. They are also good absorber of sulphur dioxide so will further reduce pollution. But, the main obstacle in their exploration is that they need proper mining technology and huge energy.

d) Polymetallic Sulphides: Polymetallic nodules are potato shaped, porous and black earthy deposits, with size ranging from 2 to 10 cm in diameter. These nodules occur at nearly 4 to 5 km depth in the deep oceans lying on the seabed. They comprise, besides manganese and iron, nickel, copper, cobalt, lead, molybdenum, cadmium, vanadium, titanium.

They are less well known than manganese nodules because their potential economic importance has only recently been recognized. They are rich in sulphur, iron, copper and smaller amount of zinc, tin, molybdenum, lead and silver. India has located such nodules in central Indian Ocean and initiated the exploration of polymetallic nodules in 1977 with the help of Research ship-Gaveshani. India has tied up with USA, UK, Russia, Japan and Germany in this field. India presently has 75000 sq km area in the Central Indian Ocean Basin (CIOB) for developmental activities targeted at harnessing of metals, viz. Copper, Nickel, and Cobalt.

e) Hydrothermal Sulphides: Recently, a major multi-disciplinary project aimed at exploration for potential sites of hydrothermal multimetal sulphide mineralization in the Indian Ocean Ridge areas has been initiated. The major objectives are as under:

- Exploration for potential sites of hydrothermal multimetal sulphide mineralization in the Indian Ocean Ridge areas.
- Identification of locales of hydrothermal sulphide deposition, including determination of the resource potential.
- Initiation of associated scientific research in the frontier areas of hydrothermal mineralization.

Geotraces in India

A network of research projects being executed by a number of research and academic institutions. The objective is to map the distribution of trace elements and isotopes in the Indian Ocean and to identify the factors influencing these distributions. The activities are various stages of implementation and currently involved in acquisition and analysis of samples.

One Oceangraphic cruise onboard Sagar Sampada was conducted in the Arabian Sea. Samples from several water profiles were collected along 680 E transect for analysis of trace elements and their isotopes in sediments and corals of the northern Indian Ocean.

Trace elements and isotopes (TEIs) play important role in the ocean as nutrients and as tracers of the contemporary and the past processes. Trace elements regulate ocean processes, such as marine ecosystem dynamics and carbon cycling. Several other trace elements also play vital roles in cell physiology and in biochemical reactions.

ENERGY RESOURCES

Almost all concepts and laws of science are the subjects related to development to improve the quality of life of our people. Science has made it possible for man to alter his living and working conditions and by doing so it is the society, which derives its benefit. Science provides new tools to society to enlarge and intensify its scope for the exploitation of resources and to use them to improve the socio-economic conditions of the people.

Evidently there are several scientific discoveries, which give us clues for their use in serving the needs of society. Since ancient times, oceans have served mankind in countless ways. The seas around India constitute a natural frontier of our country. Since times immemorial the inhabitants of India have used the seas for transport and communication for trade and

food. Recent developments in the field of oceanography have convinced that some of the biggest treasures of the world lie hidden in the sea. Oceans are, therefore, known as "our last frontier".

Energy from Oceans: There are at least eight sources of energy to be obtained from the sea. The various methods of extracting energy are from:

1. Ocean waves
2. Ocean tides
3. Ocean Thermal Energy Conversion (OTEC)
4. Ocean currents
5. Ocean winds
6. Salinity gradient
7. Ocean geothermal
8. Bioconversion of seaweeds

Ocean Waves: Ocean water is kept under constant motion by the waves, which are seen at the surface. This continual motion can be harnessed to produce energy. The vertical rise and fall of successive waves is used to activate either a water operated or air-operated turbine. In many designs the air-operated turbine is being preferred. An Oscillating Water Column (OWC) is built or fabricated in steel with an inlet at the bottom for the entry and exit of the waves. With the incoming wave the water-column rises pushing the air at the top which is forced upwards to rotate a turbine and with the outgoing waves the water column goes down allowing the air to be sucked in rotating the turbine in the same direction to generate power. The stronger wave action, and the wave height, the greater would be the power generated.

Our country, using the above method (OWC) has designed a wave energy plant, which is being built in Kerala. The ocean engineering centre of the IIT, Chennai after several years of painstaking efforts has been able to develop an indigenous design. After the wave energy plant is commissioned it would be the first of its kind in the world.

Ocean Tides: It is the most popular and feasible method of producing power. The regular flow and ebb tides (high and low water) are produced by astronomical gravitational forces of the sun and the moon. If the differences between the high and the low tide is large and if either a natural or an artificial water storage facility (reservoir) is available, power can be produced. The incoming tide is allowed to flow into the reservoir through a dam provided with turbines to generate power. Similarly, the outgoing tide is again made to flow through the same dam to turn the turbine for generating power. Such tidal power stations are built in areas where the tidal range is large. In France, a tidal power plant has been operating in the La Rance estuary for a long time. The plant was commissioned in 1980 and produces 230 mw of power. Another tidal power plant is in operation at Kislaya Guba in the Barents Sea. Tidal power plants are being designed in the Bay of Fundy, Canada, Severn estuary in U.K. and in the Bay of Cambay and Kutch in India where tides have been found to be of the right range.

Ocean Thermal Energy Conversion (OTEC) Plant: In tropical waters we find warm water at the surface and cold water in deeper layers. The difference between the two within 100 m depth could be about 20°C or more. If such a situation exists it is possible to conceive Ocean Thermal Energy Conversion (OTEC) plant. The sun heats the ocean and its energy gets stored in the topmost layers leaving the water of deeper layers cold. The principle of an OTEC plant is simple. A "working fluid" like ammonia or propane with a low boiling point is pumped into a closed tube exposed to warm water. The heat of the warm water vaporizes the working fluid; this vapour is then taken to the cold water zone where it condenses to give back the fluid in liquid form. If this vapour is allowed to pass through a turbine it can turn to generate power. The vapour is allowed to pass through a condenser in the cold water zone to get the liquid condensed. Thus we need heat exchangers (evaporator and condenser) with a turbine and electrical generator in the middle. The working fluid is pumped up and made to circulate.

The entire system can be built on the shore with two tubes, one small to pump warm water from the surface and the other long to pump cold water from deeper parts to get the cycle established.

Ocean Currents: Sweeping all along the coastline are the ocean currents. There are a number of designs available to convert the

energy of the fast moving current into electrical power by allowing the water to pass through a series of turbines installed under water. The main problem of harnessing the energy from the currents is their low energy density with considerable risk in maintaining these structures in position.

Ocean Winds: Coastal areas normally have stronger winds and therefore, much more energy is available from wind. Also in contrast to gusty nature of wind found on land the variation in wind speed is far smoother along the coast. Suitable designs are available for windmills with Battery bank systems for storing power. In several countries, such systems have been installed along the coast and on offshore structures operating away from the coast. Meteorological data show that the average speed of wind in the world in the lower atmosphere is about 10 m/s. The density of air being 1.1 kgm3 the available wind power is of the order of approximately 500 W/m^3 of the collected flow. Steadiest winds are found in the trade wind zone. Icing and hurricanes are some of the problems associated with the trade wind zone to be solved before power generation on a large scale, could begin.

Salinity Gradient: The principle for tapping energy, from salinity differences is simple. If there are two water bodies with different salinities available these are kept under controlled conditions and if a semi-permeable membrane is placed between them the water with a lower salinity begins to flow through the barrier until both attain equal concentrations. This is based on the principle of osmosis and the movement of ions can cause the electrical current. Salinity power uses the concentration gradients of salts in the sea to generate power. In Sweden a pilot study is being conducted to generate power of 200 MW.

Ocean Geothermal: This source has a very limited value at present. There are many regions of the earth where the temperature is higher as we go deeper into the earth's crust. Certain areas of the ocean contain hot spring with temperature as high as 50°C and from such a temperature difference it is possible to extract energy. The geothermal situation is the reverse of the ocean thermal energy conversion (OTEC). In the former case, the temperature is low at the surface of the sea bottom but high as we go deeper into the earth crust and in latter case it is high at the surface of the sea and low at deeper layers.

OCEAN DEVELOPMENT IN INDIA

India has more than 7500 km long coastline including the islands and about 2 million sq.km of Exclusive Economic Zone. Since it has been visualized that ocean has the vast potential of endless economic resources, various steps have been taken to develop and exploit its resources. First of all, multidimensional ocean research ship 'Gaveshani' was employed in this field in 1975. After that in 1979 Ocean Science and Technology Authority was set up in order to probe India's potential in the field of ocean research and development. However, the landmark step was taken in 1981 when the Department of Ocean Development was set up. Two research vessels, Sagar Kanya from Germany and Sagar Sampada from Denmark, were engaged in the field of ocean research and development in the year 1983 and 1984, respectively. A fleet of six scientific research vessels are under operation in 2012-13 for undertaking oceanographic research activities. These are: ORV Sagar Kanya, FORV Sagar Sampada, TDV Sagar Nidhi, BTV Sagar Manjusha, CRV Sagar Paschimi and CRV Sagar Purvi.

The main objectives of Ocean Development in India are:

(i) Exploration and assessment of marine living and non-living resources. Sagar Kanya and Sagar Sampada have done a lot in this area.

(ii) Deep sea-bed exploration, especially of polymetallic nodules. The commercial exploitation of 6 elements-sodium, calcium, chlorine, bromine, magnesium and sulphur is possible from the sea-bed. The prominent institutions engaged in the exploration of deep sea-bed are National Institute of Oceanography, Goa; Central Mechanical Engineering Institute, Durgapur; National Metallurgical Laboratory, Jamshedpur; RRL, Bhuvaneshwar; and HZL, Udaipur.

(iii) Antarctica Expedition is another aspect of ocean development which was

started in 1981. Antarctic Study Centre, Goa is the nodal agency to regulate the different expedition. Indian scientists have already established three permanent stations-Maitri, Dakshin Gangotri and Bharati in Antarctica.

(iv) Development of coastal zone and islands. It is an integrated approach which covers the overall development of the coastal area. Five centres of marine satellite information services have been set up to gather the information. For pollution control Coastal Ocean Monitoring and Prediction System has been established. Some other steps taken for the development of the coast are the Wave Energy Development Programme, Sea Level Monitoring and Modeling, International Geosphere-Biosphere Programme.

(v) Oceanic-Meteorological survey is the prime goal of ocean development, which is of significant use in weather forecasting.

(vi) Useful role in marine science and technology in the international arena is also an important objective as declared in the "Ocean Policy Statement-1982". The Ocean Policy Statement is primarily aimed at utilisation of marine living and nonliving resources for societal benefits in a sustainable manner.

In India, the Department of Ocean Development carries out a periodic monitoring of the marine habitat. Started in 1991, the coastal ocean monitoring and prediction system (COMAPS) collects information on 25 parameters from 77 locations in the country, with the assistance of 11 Research and Development Organizations.

The UNESCO had declared 1998 as the International Year of the Ocean and chalked out a host of ambitious plans and programmes. The International Oceanographic Commission (IOC), an independent body in the UNESCO family, was the nodal agency for the co-ordination of world-wide activities planned for the International Year of the Ocean. The main aims of the International Year were to raise awareness of the oceans and coastal areas as economical assets, to obtain commitments from governments to take actions, etc. As part of the International Year of the Ocean, DOD proposed to display its research ship "Sagar Kanya" for a study of the characteristics of the aerosol over the oceanic regions and their optical effects. The Indian satellite Oceansat and INSAT-3D are totally dedicated to ocean related services.

Considering the need for capacity building and specialised skilled human resources as emphasised in the Ocean Policy Statement, Department of Ocean Development has established national institutes, viz. National Institute of Ocean Technology (NIOT) at Chennai, National Centre for Antarctic and Ocean Research (NCAOR) at Goa, Indian National Centre for Ocean and Information Services (INCOIS) at Hyderabad, Project Directorate, Integrated Coastal and Marine Area Management (PD-ICMAM) at Chennai and Centre for Marine Living Resources and Ecology (CMLRE) at Kochi.

ANTARCTIC RESEARCH

In March 2012, India successfully commenced operations at Bharati, the third permanent station in the Antarctica. The summer complement of the 31st Indian Scientific Expedition to Antarctica returned from Antarctica after completion of targeted activities.

During the 6th expedition to the Southern Ocean 2011-12, continuous observations were carried out for ocean currents, atmospheric parameters and biogeochemistry by operating various instruments.

India entered in the field of Antarctic research with its first expedition 'Operation Gangotri' in December 1981. The third expedition constructed the permanent scientific research station 'Dakshin Gangotri' in 1983-84. The second research station 'Maitri' was set up in 1988-89. The various scientific programmes of Antarctic Research included studies in the field of meteorology, radio-wave-propagation, geology, Geophysics, Oceanography, Marine biology, Microbiology, upper atmosphere chemistry, Glaciology, etc. India was admitted as a consultative member of Antarctic treaty in 1959. In September 1983, India became a member of the scientific committee on Antarctic

Research. India acceded to the convention on the conservation of Antarctic Marine Living Resources from July 17, 1985 and became full time member of the Commission from September 1986.

Antarctica is the seventh continent of the world. It covers about 14 million sq. km area with about 5, 12,000 sq. km ice-free area. Up to seventh decade of 20th century, this was considered as an abandoned area for mankind, but after the discovery of ozone hole in Antarctica, this abandoned region was visualized with great importance and at the same time other useful areas were discovered. Antarctica is rich in biological resources. Seals, more than 40 species of birds, fungi, algae, grasses, penguins, etc., are found here. Krill of Antarctica is one of the most famous and abundant resource of the world with the estimated stock of 1000 million metric tonnes of which at least 40-50 million metric tonnes could be harvested annually without endangering the stock. Antarctica ice cap contains 70% of world's fresh water store and more than 90% of ice. The ice-free region of Antarctica has been visualized as having large scale mineral deposits. And this region is probably the world's biggest coal-field.

The Indian Antarctic Research Programme has been designed to take advantage of the unique site and environment of Antarctica towards understanding the key global processes that govern our future well being. The scientific programmes are essentially part of it and rooted in the following long-term programmes:

(i) Ice-Ocean-atmosphere system in Antarctica and global environment.

(ii) Antarctic lithosphere and Gond-wanaland reconstruction framework for delineating plate tectonic processes and assessment of mineral resources and hydrocarbons.

(iii) Antarctic ecosystem and environmental physiology.

(iv) Solar terrestrial processes.

(v) Innovative technologies for support systems.

(vi) Environmental impact assessment.

(vii) Generation and structuring of data bases-geological, topographic, thematic mapping and ecosystem changes, environmental parameter, health care, etc.

The purpose of the Indian Antarctic research is to identify and initiate studies and programmes, which are of significance in scientific and economic terms and to establish infrastructure facility and expertise which would enable India to sustain and expand its activities. Furthermore, it would add to our knowledge of the various features related to the Indian Ocean and also to the weather related to monsoon. Antarctica is also crucial to global weather phenomena, such as, air circulation pattern, the cold phases and the sea currents.

India hosted and chaired the meeting Asian Forum for Polar Sciences in New Delhi on 6-7 August 2012. China, Japan, Korea, Malaysia and host India participated in the meeting and exchanged information on the activities carried out in the Antarctic, Arctic and Southern Ocean.

India won the bid for hosting the Scientific Committee on Antarctic Research (SCAR) – XII International Symposium on Antarctic Earth Sciences, in 2015 at Goa.

31st INDIAN SCIENTIFIC EXPEDITION

The 31st Indian Scientific Expedition to Antarctica was launched in October 2011 and culminated in March 2012 with the commissioning of India's Third Antarctic Station "Bharati" on 18th March 2012.

Some of the major projects implemented by the Indian Scientists at Maitri and Bharati during the summer and winter months of 2011-12 comprise: ionospheric studies by the National Physical laboratory, Temporal and Spatial Variations of meteorological parameters, by Snow and Avalanche Study Establishment (SASE), Meteorological parameter observations by ESSO IMD, Geophysical Studies by the Indian Institute of Geomagnetism and National Geophysical Research Institute, Hydrographic Surveys by the National Hydrographic Office, Glaciological Studies by the Geological Survey of India and Geochemical and petrological studies of lamprophyres of Central Dronning Maud Land (CDML), by Nagpur University.

32nd INDIAN SCIENTIFIC EXPEDITION

The 32nd Indian Scientific Expedition to Antarctica (2012-13), was launched in November 2012 from Cape Town. The major activity includes construction of seawater intake facility and an earth station to receive remote sensing data at Bharati. In view of the mammoth tasks ahead, a logistic team of 40 members comprising doctors, engineers, mechanics and technicians has been working at Bharati presently.

ARCTIC MISSION OF INDIA

Taking advantage of the unique International Svalbard Treaty signed in 1920, to which it was a signatory, India will be able to set up a permanent research station at Ny Alesund, on the Svalbard archipelago which comes under Norwegian sovereignty, boosting its knowledge of climate change, other critical natural phenomena and the disturbance of humans cause to nature's processes. India has already sent 26 missions to the Antarctic and has two permanent bases there, the research base at 79 degree north will be set up under a five-year contract with the Norwegian government and Kings Bay, the Norwegian government-held company that runs the logistics at the research station.

The Svalbard Treaty allows every signatory country that includes Afghanistan, to set up any business and activity on the archipelago - which was earlier better known for its coal mining industry - as long as it falls within Norwegian regulations. Formal negotiations between the two countries are close to completion for India to take position close to the North Pole. The move to set up a permanent station at Ny Alesund matured with India sending its first Arctic mission. Three of the five researchers sent as part of the first of the two teams comprising the mission have already made themselves at home at the international research station.

The second Arctic expedition of the country was launched in two batches viz. First Summer batch (June-July 2008) and Second Summer batch (July-August 2008). During the second Arctic expedition, India established a research station at Arctic named 'Himadri' at Ny-Alesund in Svalbard region of Norway. The 3rd Indian Arctic Expedition has been launched in three phases (June-July 2009, August 2009 and March-April 2010).

The summer phase I of the Indian Arctic Programme was completed between June – July 2012. The studies on (i) Long term monitoring of the Kongsfjorden system of the Arctic region for climate change studies and (ii) Quantifying variability in freshwater influx to the Kongsfjorden system using oxygen isotopes of seawater and the implications to the ice melting have been undertaken.

GEO-STRATEGIC IMPORTANCE OF INDIAN OCEAN

Indian Ocean is the third largest ocean of the world. It covers 20.7 per cent ocean area which is 7.5 crore sq. km. It is the only ocean named after a country, indicating India's association with this vast water-body since the dawn of human civilization. India lies at the apex of the triangular water-body and has rightly been called 'the crown of the ocean'. India covers about 1/8th coastline of the ocean. The ocean is bordered by 46 littoral and island sovereign States. India is not only the largest in area just after Australia, but alone has more than 50 per cent population of the region. Circled on the north by India and Arab countries, in the west by Africa, east by Malaysia, Indonesia, etc. and south by Antarctica, it is an 'embayed ocean' or landlocked sea.

It was not until 1500 AD that the real importance of this centrally-located ocean was recognized. The Portuguese were the first to understand the military importance of this ocean and within 17 years of the arrival of Vasco-de-Gama, they were in the commanding position. They took command of Malabar region for re-export of East Indian spices, and Goa became their capital. Besides Goa, Daman and Diu, Portuguese base were made at Madras, Hooghly, Chittagong and Ceylon. But, the fall of the Strait of Malacca to the Dutch in 1595 led to the collapse of the Portuguese defence system. By that time, British and French presence was also felt.

The Britishers dominated Indian Ocean during their rule over India. But after World War-II, British Government started gradually

reducing its presence in the ocean zone due to declining interest. British Government decided to withdraw all the bases by 1971. The most important decision was the selling of Diego Garcia to U.K. by Mauritius and then to U.S.A. on a contract by U.K. for communication purpose. But, Diego-Garcia has now been converted into a military base in the Indian Ocean.

MARINE ENVIRONMENTAL DEGRADATION

I. Induced changes of Sea Level

There is a likelihood of an accelerated rate of sea level rise in the present century as a result of culturally induced global climatic change, specially the global warming. Many scientists expect a rise of up to 60 cm by the year 2050, up to 1m. by 2100 and up to several metres by 2200. Environmental change on such a scale would be without precedent and the impacts would be serious.

The projected sea level change in the near future caused by global warming will have an effect on shrinkage of the land area and the wiping out of some islands because of drowning. There are many possible impacts of such rise. These include:

1. Damage to many important coastal ecosystems, including deltas, coral atolls and reefs;
2. Flooding of many densely populated areas;
3. Damage to port facilities and coastal structures;
4. Severe coastal erosion in many countries, including loss of beaches and dunes;
5. Salinization of many important ground water resources through salt water intrusion;
6. Decline of loss of production in up to one-third of the world's croplands.

Scientists accept that some global increase in sea level is now inevitable, but they stress that rate and extent of change depends on what action is taken by society today. Important decisions will have to be protected with dykes and embankments, like the Thames Barrier. Already rising sea level is causing serious ecological problems in some parts of the Pacific Ocean. The Cartel Islands, one of the most densely populated coral atolls in the Pacific, lie to the north-east of Papua New Guinea and they are experiencing problems that prevent the inhabitants from supporting themselves from their own resources.

II. Marine Pollution

Pollution of environment especially marine pollution is a worldwide phenomenon. Oil spills and conspicuous acts of dumping hazardous wastes e.g. radioactive material at sea have attracted greater attention in recent years to the dangers of oceanic pollution. Some of the major marine pollutants are mercury, lead, pesticides, petroleum, radioactive elements, etc.

Most of the marine pollutants originate on the continent and reach the oceans via the atmosphere and rivers. Oceanic pollution cannot be controlled unless the releases of the materials that pollute the oceans are controlled. Shipping accounts for only 10 per cent while pollution from land-based sources account for 70-75 per cent of all marine pollution. As per the observations of United Nations Environment Programme (UNEP), some 70 per cent of the waste discharged into the Pacific Ocean receives no treatment. About half of the countries in West Asia have an oil-based economy which has given some countries the resources to develop an extremely intensive agriculture which has led to the pollution of the food chain and of rivers and marine seas.

A serious form of marine pollution is the introduction of non-indigenous species through ballast water. This is sea water that is taken on board, for example at the outset of voyage, in order to stabilize a ship and its cargo. Once at destination, this water-and all the bacteria, viruses and organisms it contains-is released. This is a big problem for Australia. Apparently, organisms used to cold water cannot survive in the tropics and vice versa. Similarly every year million tonnes of fish are thrown back, dead, because they are inedible, unwanted or too small to be marketed.

However, the problem of regular oil spill has been a subject of debate worldwide in

the recent past. The importance of controlling oil pollution at sea lies not only in its short-term effects but also the long-terms effects on marine life and environment. There are many short-term effects of the oil-spill. Shore properties and beaches can be extensively contaminated. Slow moving crustaceans and inter-tidal marine life can be physically damaged by heavy spills of oil. The oil-film forms a barrier to the transfer of oxygen into the water to support marine life. The long-term effects of oil pollution are two-fold. Once incorporated into a particular marine organism, hydrocarbons are stable and pass through many members of the marine food chain without alteration eventually reaching organisms that are harvested for human consumption. Another effect results from the low level interference of oil pollution with marine ecology. Oil pollution interferes with natural processes by plugging taste receptors and distorting natural stimuli which may threaten some marine species.

III. Corals in Danger

Global climate change, or the enhanced greenhouse effect, may cause increase in sea temperature and sea level, as well as changes in ocean current patterns, that could damage coral reefs. For example, corals are very sensitive to changes in temperature. Sea-water that becomes too warm causes corals to turn white, or bleach, a reaction that occurs if coral polyps are stressed. Often they recover, but they are also known to die. If the oceans warm up as a result of global climate change, corals may have increasing difficulty recovering from bleaching episodes. Coral reefs are being over-exploited on a global basis. It is increasingly difficult to make a living from fishing, as first the big, commercially valuable species such as groupers disappear, and then the smaller ones. Often damaging harvesting methods such as poisons and dynamite are used. Overfishing tends to be followed by a change in the ecological balance of the reef. For example, it becomes overgrown with algae if grazing species are removed. Corals and shells are collected all over the world to sell as souvenirs or to make into jewellery and other handicrafts.

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INDIA IN SPACE

CHRONICLE
IAS ACADEMY
A CIVIL SERVICES CHRONICLE INITIATIVE

Man's evolution and progress are closely linked with how efficiently he stores and disseminates information. The Vedas were handed down by word of mouth. The invention of writing extended communication beyond the reach of the spoken word. Thereafter, the invention of the printing press by Johann Gutenburg in 1455 brought about a major change in the life style of the human race. The discovery of radio waves in 1888 by Hertz resulted in radio broadcasting, which cut across the limits of time and space. The next breakthrough in information dissemination came in 1945 with the prediction by Arthur C Clarke, a British scientist and science fiction writer about the feasibility of global communications (including TV) by using man made artificial satellites.

BRIEF HISTORY

Space research has always been a challenge for both man and science. The initial emphasis was on exploration of the unknown celestial bodies and development of space probes and related systems. But, gradually space applications became very important in a wide range of areas. The region beyond the Earth's tangible atmosphere-160 km from the surface-first became accessible to man when 'Sputnik-I' was put into orbit by the erstwhile USSR in October 1957. In 'Sputnik- II', launched by Russia, a dog Laika was sent in the space. The physiological examination of Laika revealed that human beings might also survive prolonged period in space. In January 1958, the National Aeronautics and Space Administration (NASA) of USA launched 'Explorer-I' satellite in space. The major contribution of Explorer-I mission was the discovery of the Van Allen radiation belts around the Earth where electrons and protons from the sun are trapped by the Earth's magnetic field. Far side of the Moon's glimpse in the history of mankind was observed from the Russian satellite 'Luna- III' in October 1959. April 2, 1961 was a landmark in history when the first ever manned spacecraft, 'Vostok - I', was injected in space and a Russian cosmonaut Yuri Gagarin became the first person to travel in space. On June 16, 1963 Valentina Tereshkova, a Russian cosmonaut was registered as the first woman in the world to travel in the space and to stay in orbit for up to five days through the 'Vostok-VI' spacecraft.

In 1960s, the space science widened its nature and scope. Now the space scientists concentrated their studies around the exploration of other celestial bodies like the Moon, Venus and Mars. The US 'Mariner-II' in 1962 flew past the planet Venus and calculated its temperature and its reverse direction of rotation. In 1965 'Mariner-IV' sent back clear photographs indicating craters on Mars. American astronauts made more modest flights in their smaller Mercury spacecraft. In 1965, USA launched the Gemini-series programme for the preparation of Apollo mission to the Moon. On December 21, 1968 a landmark in history was created when the first manned voyage to the Moon took place by an American spacecraft 'Apollo-8', which orbited the Moon 10 times and returned safely to the Earth. July 21, 1969 was a memorable day in space history when four legged Lunar Module of 'Apollo-11' landed on the surface of the Moon along with US astronauts Neil Armstrong and Edwin Aldrin.

In 1970s, space scientists developed the capability to establish permanent space exploration centre and established the Skylab & Salyut space stations.

In 1977, the first shuttle 'Enterprises', which was a modified form of 747 jumbo jet along with a rocket launcher, was injected into space by NASA. The shuttle carried the orbiter into the air and back on several flights and released it in mid-air. The shuttle's first orbital mission began on April 12, 1981 when 'Columbia' was launched. In June 18, 1983 the shuttle 'Challenger' was sent into space which took Sally

Ride, the first US-women to space. In April, 1984 the major achievement in space technology was created when the satellite Solar Max was successfully repaired and the astronauts walked in space for as long as 6 hours and 44 minutes. In March 1989, the space shuttle 'Atlantis' launched a spacecraft on the voyage to Venus. In October 1990, the US shuttle 'Discovery' again launched the scientific spacecraft 'Ulysses' into space in order to probe the polar region of the Sun.

In February 1986, a major landmark in space history was achieved when the third generation space laboratory 'Mir' was launched into space. The Soviet Union joined the era of space shuttles in November 1988, when its first reusable shuttle 'Buran' was launched on the world's most powerful booster rocket 'Energia'.

The Ulysses space mission, undertaken jointly by the European Space Agency and NASA was launched in October 1990 to explore regions of space above the poles of the Sun. Observations made by the spacecraft have led to several major discoveries concerning the physical properties of the region and, thus, have contributed to a better understanding of the solar atmosphere. Of particular importance are the discoveries on the structure of the space medium in the helioshpere and its properties; nature and region of solar wind and the access of cosmic rays into the solar system. Sudden changes in the solar winds cause large disturbances in Earth's magnetic field. Ulysses was also expected to resolve doubts over origin of solar activity cycle. The cycle initiates changes in solar winds, solar atmosphere, etc.

Another monumental contribution by Arthur Clark which has had far reaching implication was the idea of a Geo-synchronous Earth Orbit (GEO)' a belt' approximately 36800 km over the equator. A satellite placed exactly in the 'Clark orbit' appears stationary to any observer on the earth.

Theoretically three satellites placed 120 degrees apart are sufficient to provide global coverage for all types of information, including T.V. Such a system which requires minimum infrastructure on the ground became a reality in 1963 with the launching of SYNOCOM III (synchronous communication satellite). Commercial exploitation of satellite broadcasting started in 1964-65 with the formation of INTELSAT, a global consortium of over 125 countries each becoming a shareholder in the space segment, consisting of satellites in the geo-synchronous orbit over the Indian, Atlantic and Pacific oceans to cover the entire globe. The "ground segment" consisting of ground stations to operate with the INTELSAT satellites was the responsibility of each member country. In India and the Commonwealth nations, this agency is a government department or a corporation. India became a founder member of INTELSAT in 1965 and got ready to set up its own ground station at Arvi near Pune.

Theoretically 32 satellites can be accommodated with a 50 degree separation in the GEO. However all these 32 slots or parking lots are not suitable since they lie over oceans or uninhabited landmasses. Satellite communications are very much more energy efficient than short wave radio and when first introduced it was expected to be a panacea for all the ills affecting long distance communications.

Satellite based communication is now being used for long range mobile stations like ships, boats, aircrafts, railways and road transports where the cellular radios cannot meet the demand. In fact, in many instances, satellite technology is the only means to provide a chance to get reliable and effective communication between fixed site and remote mobile vehicles. The International Maritime Satellite Organisation (IMNARSAT) has been providing real time communication services, including TV broadcasting and emergency and rescue services to ships at sea since 1982. Management of mobile fleets whether at sea or in the air or on the ground, by real time positioning from one central location, is a very exciting prospect in the not too distant future. GEOSTAR of USA is one such system.

Satellite communication involves three main systems the satellite, the rocket and the launch facility to place it in orbit, and the ground segment to transmit and receive data. Only a few countries own all the three because their development involves enormous resources and the manpower of thousands of scientists and engineers.

Satellites offer a solution to the overcrowding of the entirely earth based channels of

communication. A satellite at a distance of hundreds or thousands of miles above the earth has a considerable area of the earth's surface in its line of sight and therefore, they can relay signals from one earth based station to another.

There are two methods by which this relaying may be effected. Some satellites merely reflect the signals and are therefore known as passive satellites. Others receive and retransmit them and are known as active satellites. Also communication satellites may be classified according to their orbits as sun-synchronous and geo-synchronous.

The area of the earth within the line of sight of satellites that orbit close to earth obviously is not as wide as that of satellites at greater heights. So satellites are placed at a lower height. Spacing of satellites, signals would still need to be transformed frequently between satellites.

SPACE PROGRAMMES IN INDIA

The foundation of space research in India was laid in 1961 when the Government of India entrusted the task of developing a programme on space research to its Department of Atomic Energy. The Department of Atomic Energy set up a National Committee which identified two major objectives for India's space research programme. These objectives were:

(i) To utilise space technology for the rapid development of Mass communication and education, especially in the far-flung rural areas, and

(ii) To utilise space technology for the timely survey and management of the country's natural resources.

After laying the foundation of space research in India, it was realised that the vast potential of space technology can be used for the socio-economic development of the country only by developing indigenous techniques for placing a satellite in the Earth's orbit. In order to boost the technological efforts to make India self-reliant in the field of space technology, a Space Commission was set up in 1972 and a separate Department of Space (DoS) was established thereafter. The DoS executes its space programmes through the Indian Space Research Organisation (ISRO). The basic requirements for attaining self-sufficiency in the field of space technology may be summed up as:

(i) To develop expertise in planning, designing and fabricating the satellites or spacecrafts for various purposes;

(ii) To develop suitable launch vehicles (i.e., rockets) which could place satellites in Earth's orbit;

(iii) To establish 'Earth Stations' for launching, tracking, controlling and guiding the satellites; and

(iv) To develop ground facilities for using space technology for mass communication.

The Indian space programme has three thrust areas:

(a) Development of communication through satellite;

(b) Development of remote sensing for resource survey and management, environmental monitoring and meteorological services; and

(c) Development of indigenous satellites, as also their launching.

SPACE VISION INDIA 2025

A Space Vision 2025 was unveiled at the Indian Science Congress-2003, in Bangalore. The emphasis was on achieving self-reliance in launching capabilities and end dependence on foreign agencies for the same. Self-sufficiency has been achieved in the fabrication of satellites. Mission to moon also forms part of the Vision.

- Satellite based communication and navigation systems for rural connectivity, security needs and mobile services.
- Enhanced imaging capability for natural resource management, weather and climate change studies.
- Space science missions for better understanding of solar system and universe Planetary exploration.
- Development of Heavy lift launcher.
- Reusable Launch Vehicles - Technology demonstrator missions leading to Two Stage To Orbit (TSTO).
- Human Space Flight.

INFRASTRUCTURE

The Space Commission's tasks include framing of policy, approval of space programme budget and implementation of national policy in all matters concerning outer space.

Many organisations and research centres have been established to carry out research and developmental activities related to the various segments of the space research programmes. The Indian Space Research Organisation (ISRO) is one such organisation. The various tasks which have been assigned to ISRO are:

(i) to develop the know-how to fabricate the rockets, its propellants, its control and guidance systems; and

(ii) to design and fabricate the satellites.

Thus, ISRO is responsible for planning, programming and management of research and development activities in the country in space science, technology and applications. The ISRO council and ISRO headquarters provide overall direction to the scientific, technological and management tasks of the ISRO centres and units. Research in space sciences is also supported in several institutions by the multi-agency Indian Middle Atmosphere Programme (IMAP) and the Advisory Committee for Space Sciences (ADCOS).

ISRO also disseminates know-how to industries to market the 'spin offs' of the national space efforts. It also provides consultancy services to the industrial and technology sectors of the country, utilises the manpower and infrastructure available with these sectors for its space programmes. The know-how transferred to industry includes chemicals, polymers, special materials, instruments, telecommunications, TV equipment, electronic sub-systems, electro-optic hardware, computer software and special purpose machines.

LAUNCH VEHICLE TECHNOLOGY

The rocket programme in India began with the establishment of the Thumba Equatorial Rocket Launching Station (TERLS) in 1963 for launching sounding rockets equipped with instruments to conduct meteorological or scientific observations. Initially, foreign rockets were used and later on the Rohini Sounding Rockets (RSR) were developed indigenously. Currently being used is RH-200 which can lift a payload of upto 50 kg for altitudes of 140-150 km, and RH-560 with payloads of 100 kg for altitudes upto 350 km.

In the field of launch vehicle technology, India has evolved a four-stage development programme, i.e., SLV, ASLV, PSLV and GSLV.

Launch Vehicles are used to transport and put satellites or spacecrafts into space. In India, the launch vehicles development programme began in the early 1970s. The first experimental Satellite Launch Vehicle (SLV-3) was developed in 1980. An Augmented version of this, ASLV, was launched successfully in 1992. India has made tremendous strides in launch vehicle technology to achieve self-reliance in satellite launch vehicle programme with the operationalisation of Polar Satellite Launch Vehicle (PSLV) and Geosynchronous Satellite Launch Vehicle (GSLV)

PSLV represents ISRO's first attempt to design and develop an operational vehicle that can be used to orbit application satellites. With PSLV, a new world-class vehicle has arrived. PSLV has repeatedly proved its reliability and versatility by launching 63 satellites / spacecrafts (28 Indian and 35 Foreign Satellites) into a variety of orbits so far.

ISRO also makes the Rohini series of sounding rockets used by the Indian and international scientific community to launch payloads to various altitudes for atmospheric research and other scientific investigations. These rockets are also used to qualify some of the critical systems used for advanced launch vehicles.

Satellite Launch Vehicle-3: India's first satellite launch vehicle was the SLV-3. The first successful launch placed a 35 kg RS-1 satellite into a low Earth orbit in July 1980. This was the culmination of about seven years of developmental effort. The next two launches of SLV-3 took place in 1981 and 1983. The 22.7 metre long SLV-3 was a four stage solid propellant vehicle with a launch weight of 17 tonnes.

In the first stage, the development of SLV-3

was a major achievement in India's space capability by placing the 40 kg Rohini satellite into near Earth orbit of 300 Km. With the three successful launching of SLV-3, India became the sixth country in the world to have the capability to orbit its own satellite.

ASLV: In the second stage of the launch vehicle development programme, ASLV was developed, which was basically a derived form of SLV-3. It also used solid propellant in its all four stages.

The Augmented Satellite Launch Vehicle (ASLV) was designed to place a 150 kg satellite (SROSS) into a 100-km orbit. This constitutes an addition of two first stage rocket motors as strap-ons to the sides of the SLV-3 first stage. The heat shield, which protects the satellite from the heat generated as the vehicle speeds through the dense atmosphere, has been made to accommodate the large spacecraft. In addition, a closed loop guidance system incorporating a Stabilised Platform Inertial Navigation System (SPINS) and a micro-processor based navigation and guidance computer has replaced the open loop guidance system used in the SLV-3 in order to achieve a more accurate control of the trajectory. Some of the other changes include a change over to S-band frequencies from VHF to comply with international regulations for radio transmissions, use of KEVLAR fibre for the fourth stage body in order to increase the payload capability, etc. The lift-off weight of ASLV is 39 tonnes and its height being 23.5 metres.

Polar Satellite Launch Vehicle: The four-stage, 275 tonnes, 15 storey tall (44 m) PSLV has heralded a 4 new era in the country's space programme as the first rocket to use liquid propellants in its two stages. Liquid propellants, developed here itself, are the latest in space technology.

In the third stage of launch vehicle development programme, the concept of the use of liquid propellant was taken in the form of PSLV programme, which was approved in 1993. PSLV series of launch vehicles have the capability to inject the pay-load of 1000 kg polar satellites in the orbit of 900 km. This was the first launch vehicle in India, which used liquid propellant along with solid propellants. PSLV is a four-stage rocket, with a solid propellant motor and six motors derived from SLV-3 strapped around it in the first stage. The second stage based on liquid engine technology uses liquid propellant, while the third and fourth stages have solid and liquid propellants, respectively.

The first stage of PSLV uses Hydroxyl Terminated Poly Butadine (H.T.P.B.) as fuel and Ammonium Perchlorate as oxidiser. The stage uses world's third largest booster motor made of meraging steel. The second stage of PSLV uses VIKAS engine, powered by liquid fuel Unsymmetrical Dimethyl Hydrazine (UDMH) and Nitrogen Tetroxide (N_2O_3) as oxidiser. The third stage of PSLV uses HTPB-based solid propellant. The motor of this stage is made of Kevlar (i.e., polyaramide fibre). The fourth stage, which finally injects the polar satellite into the orbit, has twin-engine configuration. This stage uses Monomethyl Hydrazine (MMH) as fuel and the oxides of nitrogen as oxidiser.

The reliability rate of PSLV has been superb — There had been 23 continuously successful flights of PSLV, till July 2013. With its variant configurations, PSLV has proved its multi-payload, multi-mission capability in a single launch and its geosynchronous launch capability. In the Chandrayaan-mission, another variant of PSLV with an extended version of strap-on motors, PSOM-XL, the payload haul was enhanced to 1750 kg in 620 km SSPO. PSLV has rightfully earned the status of workhorse launch vehicle of ISRO.

PSLV-C22 Launched: On July 01, 2013 Polar Satellite Launch Vehicle, in its twenty fourth flight (PSLV-C22) launched India's first dedicated navigational satellite IRNSS-1A. The launch took place from the First Launch Pad (FLP) of Satish Dhawan Space Centre, (SDSC) SHAR, Sriharikota. PSLV-C22 used 'XL' version of PSLV. This is the fourth time such a configuration has flown, earlier three being PSLV-C11/ Chandrayaan-1, PSLV-C17/ GSAT-12 and PSLV-C 19/ RISAT-1 missions.

GSLV: The fourth stage of the Indian Vehicle Development Programme is the use of geo-stationary launch vehicles (GSLV). The use of cryogenic engines is in the last stage of experiment. Cryogenic engines use liquid hydrogen as fuel at-2530C and liquid oxygen at-830C as oxidiser.

The finally chosen GSLV design is a three-stage vehicle, the core being a 125 tonne solid booster as in PSLV with four liquid strap-ons of Vikas engine, each with a propellant loading of 40 tonnes. The second stage of GSLV is the Vikas liquid propulsion system as in PSLV and the last upper stage, a 12 tonne restartable cryogenic engine which uses liquid oxygen and liquid hydrogen. The most interesting aspect of GSLV is its modularity, which without strap-ons has the same capability as PSLV, with two strap-ons can launch over 1600 kg into a polar orbit and with all the four strap-ons can launch 2.5 tonnes into Geo-synchronous Transfer Orbit (GTO). Excepting for the addition of a new cryo-stage, the first two stages fully exploit PSLV pedigree. With just three stages, GSLV should prove to be a world class launch vehicle in terms of reliability, cost competitiveness and payload fraction.

GSLV Launch: GSLV was test fired successfully from SHAR on April 18, 2001. This 49 metre long and 401 tonne heavy launch vehicle along with the 1540 kg payload GSAT-1 obeyed instructions to inject the satellite into the Geosynchronous Transfer Orbit (GTO) east of Indonesia. The GTO has a perigee of 185 km and an apogee of about 36,000 km. The launch speed of the rocket was 36,720 km per hour which is 8 times the speed of any fighter plane in India.

It was followed by six more launches , GSLV-D2 on May 8, 2003 (GSAT-2 1825 kg), GSLV-F01 on September 20, 2004 (EDUSAT 1950 kg), GSLV-F02 on July 10, 2006, GSLV-F04 on September 2, 2007 (INSAT-4CR 2130 kg), GSLV-D3 on April 15, 2010 and GSLV-F06 on December 25, 2010.

The launch has put India in the selected league of nations with the capability to place multipurpose satellites in orbit and send space mission. The major gains from the launch are as follows:

India pays $70 million to Ariane space for launch of INSAT satellites. This amount can be saved. Besides, India can enter the multi billion-dollar market for launching communications satellite. At present U.S., Russia, France, Japan, China and European Space Consortium dominate this market. India can benefit through its lower launch price of Rs. 125 crore and target the lighter satellites of developing countries. However, it needs to graduate to the 4 tonne class to play a more lucrative role.

GSLV gives India the Inter Continental Ballistic Missile (ICBM) status which can direct an explosive to a distance of 5000 km. The flight has certified India's expertise in putting together powerful solid fuel propelled rocket motors. Besides, the immaculate guidance system of GSLV is an added advantage. India can move ahead confidently in this direction.

GSLV-III

The Geosynchronous Satellite Launch Vehicle Mark III (GSLV-III) is a launch vehicle currently under development by the ISRO. GSLV Mk III is conceived and designed to make ISRO fully self reliant in launching heavier communication satellites of INSAT-4 class, which weigh 4500 to 5000 kg.

GSLV-Mk III is designed to be a three stage vehicle, 42.4 m tall with a lift off weight of 630 tonnes. First stage comprises two identical S200 Large Solid Booster (LSB) with 200 tonne solid propellant, that are strapped on to the second stage, the L110 re-startable liquid stage. The third stage is the C25 LOX/LH2 cryo stage.

It would also enhance the capability of the country to be a competitive player in the multimillion dollar commercial launch market. The vehicle envisages multi-mission launch capability for GTO, LEO, Polar and intermediate circular orbits. Realisation of GSLV Mk-III will help ISRO to put heavier satellites into orbit.

Cryogenic Engine

Cryogenics is the science pertaining to very low temperatures and includes super-low temperatures of - 150 degree Celsius to - 273 degree Celsius, the latter being called the 'absolute zero' temperature. These are temperatures where gases such as Oxygen, Nitrogen and Helium are liquified. Such liquified gases, at their super-cool temperatures find application in areas like super-conductivity, in cryo-medicine and cryo-surgery (surgery carried out at very low temperatures) and rocket propulsions (where they are used as super-cooled propellants).

The difference between an ordinary liquid rocket and cryogenic rocket is in the fact that

the oxidiser and fuel used in the cryogenic engine is only liquid at below freezing temperatures, whereas in the ordinary liquid rocket the fuel and oxidiser are liquid at ambient temperatures.

Cryogenic engines, thus, are rocket engines which use super-cooled liquids as propellants. These engines use liquid Oxygen and liquid Hydrogen as fuels and the use of such engines provides greater thrust and higher degree of control.

Experiments have been tried out with kerosene and liquid oxygen. This was a quasi-cryogenic engine experiment. It would not be difficult to convert this into a cryogenic engine.

Liquid Oxygen (LOX) was the earliest, cheapest, safest and, eventually, the most preferred oxidiser for large launch vehicles. In later years, among the semi-cryogenics, LOX-Kerosene combination was found to be the best and is currently preferred worldwide for its price, safety, least toxicity and specific impulse.

All the leading rocket visionaries identified liquid hydrogen (LH2) as the theoretically ideal rocket fuel. Its combination with LOX gives the highest specific impulse with the least toxicity- the LOX-LH2 rocket exhausts essentially steam. Cryogenic propellants, semi-cryogenic propellants and storable liquid propellants, in the decreasing order- are of higher specific impulse than solid propellants. Mostly, LOX-Kerosene and LOX-LH2 are being adopted in the construction of new launch vehicles for large satellites (i.e., 2000kg and above).

In February 1998, ISRO successfully tested an indigenously designed cryogenic engine for about a minute at its Mahendragiri centre (Tamil Nadu). The thrust chamber of the engine, in which liquid Hydrogen (LH2) and liquid Oxygen (LOX) burns, is cooled by passing liquid hydrogen through channels milled into the wall of the thrust chamber. The technique for making this channel was developed at the Central Electrochemical Research Institute at Karaikudi (Tamil Nadu). The test shows that the ISRO has mastered the process for firing a cryogenic engine. Before a cryogenic engine is fired, an elaborate process has to be followed to fill the propellant tanks and to condition the fuel lines as well as the injectors. Further in Feb. 2002, India moved a step closer to the cryogenic technology when it conducted a successful test-firing of an indigenous cryogenic engine.

On March 28, 2013, successful ignition of an indigenous cryogenic engine at Mahendragiri in Tamil Nadu, in conditions simulating the high altitude atmosphere, has boosted the confidence of the ISRO to go ahead with the launch of a Geo-synchronous Satellite Launch Vehicle (GSLV-D5) in 2013. The hot-test took place in the newly-built high altitude test facility (HAT) at ISRO's Liquid Propulsion Systems Centre (LPSC) at Mahendragiri. GSLV-D5, with the indigenous cryogenic engine, will put into orbit a communication satellite called GSAT-14.

INDIAN SATELLITES

- **Aryabhatta:**

It was launched on April 19, 1975 from Baikonur Cosmodrome in the then USSR. It was put in a near earth orbit at 594 km. altitude. It orbited the earth once every 96.41 minutes. Many commands were successfully sent to the satellite. The original intention to develop satellite technology was achieved even though some scientific experiments could not be carried out.

- **Bhaskara I:**

The First Experimental Remote Sensing Satellite built in India. Bhaskara I was launched on June 7, 1979 again by the Soviets which was named after Bhaskaracharya, a sixth century astronomer and another twelfth century mathematician. Its purpose was to use satellites for development. It took about four years to develop and carried remote sensors to detect and assess natural resources from space. It also had two TV cameras and three microwave radiometers for remote sensing. SAMIR sent rich scientific data which were used for oceanographic studies.

- **Bhaskara II:**

It was launched on November 20,1981 by the Soviet Union. It was deployed in a near earth orbit of 525 km and was tracked by ground stations at Sriharikota and Ahmedabad. Indigenously developed thermal coatings, solar cells and panels were its special features.

Rohini:

A progressive space programme could not

rely on launches from foreign soil. We had to develop our own launch facility. For this, the Satellite Launch Vehicles (SLVs) were developed and to test their effectiveness, the Rohini satellites were developed. After a couple of failures in 1979 and 1980, Rohini satellite (RS-I) became the first Indian satellite to lie launched from Indian soil by an Indian rocket. It was put in orbit by SLV-3 weighing 35 kgs, it had an elliptical orbit 325 km by 950 km with a period of 97 minutes. It sent good signals to the ground stations in Trivandrum, Sriharikota, Car Nicobar and Fiji.

- **SROSS:**

Another series of satellites called the Stretched Rohini Satellite Series (SROSS) was developed for the use of scientific payloads. This was meant to be launched by the Augmented Satellite. SROSS was launched on March 24, 1987. The satellite was launched onboard the first developmental a flight of ASLV. It did not reach the orbit.

The launch of SROSS-I and SROSS-II both for technical purposes on 24th March, 1987 and 13th July 1988 proved unsuccessful. However SROSS-III was successfully put in orbit on 19th May 1992 by an ASLV. This satellite, launched for scientific purposes to detect gamma ray bursts coming from space and studying the ionosphere, also gave a boost to the ASLV effort.

- **Apple:**

On 19th June, 1981 India's first experimental communication satellite APPLE (Ariane Passenger Pay Load Experiment) was launched by Ariane Space Agency. It was used to conduct experiments on domestic communication, radio networking, data relay, and remote area communication, etc.

- **Kalpana-1:**

Kalpana-1 is the first dedicated meteorological satellite launched by Indian Space Research Organization using Polar Satellite Launch Vehicle. This was the first satellite launched by the PSLV into the Geostationary orbit. The satellite was originally known as MetSat-1 but renamed as Kalpana-1 in memory of Kalpana Chawla - a NASA astronaut who perished in the Space Shuttle Columbia disaster.

The satellite features a Very High Resolution scanning Radiometer (VHRR), for three-band images and a Data Relay Transponder (DRT) payload. The radiometer scans the earth's surface line by line; each line consists of a series of individual image elements or pixels. For each pixel the radiometer measures the radioactive energy of the different spectral bands. This measurement is digitally coded and transmitted to the ground station for pre-processing before being disseminated to the user community.

- **IRNSS-1A:**

It is the first satellite in the Indian Regional Navigation Satellite System (IRNSS) launched on July 1, 2013. It is one of the seven satellites constituting the IRNSS space segment.

Payloads - IRNSS-1A carries two types of payloads navigation payload and ranging payload. The navigation payload of IRNSS-1A will transmit navigation service signals to the users. This payload will be operating in L5 band (1176.45 MHz) and S band (2492.028 MHz). A highly accurate Rubidium atomic clock is part of the navigation payload of the satellite. The ranging payload of IRNSS-1A consists of a C-band transponder which facilitates accurate determination of the range of the satellite. IRNSS-1A also carries Corner Cube Retro Reflectors for laser ranging.

Applications of IRNSS

- Terrestrial, Aerial and Marine Navigation
- Disaster Management
- Vehicle tracking and fleet management
- Integration with mobile phones
- Precise Timing
- Mapping and Geodetic data capture
- Terrestrial navigation aid for hikers and travellers
- Visual and voice navigation for drivers

INSAT Satellite applications

Satellite Communication (Satcom) technology offers the unique capability of simultaneously reaching out to very large numbers spread over large distances even in the most remote corners of the country. The hallmark of Indian Space Programme has been the application oriented efforts and the benefits that have accrued to the country. In the past

two and a half decades Indian National Satellite (INSAT) system have revolutionized the country's telecommunications, TV broadcasting, DTH services, business communications, rural area connectivity, Tele-education, Tele-medicine, Village Resource Centres, Search and Rescue operations and Emergency Communications.

"INSAT system is a joint venture of the Department of Space, Department of Telecommunications, India Meteorological Department, All India Radio and Doordarshan. Established in 1983, INSAT system is one of the largest domestic communication satellite systems in the Asia Pacific Region with eleven satellites in operation. These satellites carry more than 200 transponders in the C, Extended C and Ku-bands, besides meteorological instruments.

INSAT is used for a variety of societal applications in the area of Tele-education, Tele-medicine and support to the Disaster Management System (DMS). Village Resource Centre (VRC), a single window agency providing the services offered by INSAT and IRS satellites to provide information on natural resources, land and water resources management, Tele-medicine, Tele-education, adult education, vocational training, health-care and family welfare programmes, has been established. Meteorological data from INSAT is used for weather forecasting and specially designed disaster warning receivers have been installed in vulnerable coastal areas for direct transmission of warnings against impending disaster like cyclones.

a) EDUSAT Programme

EDUSAT, launched by Geosynchronous Satellite Launch Vehicle (GSLV-F01) in September 2004, is India's first thematic satellite dedicated exclusively for educational services. The satellite is specially configured to relay through audio-visual medium, employing multi-media multi-centric system, to create interactive classrooms. EDUSAT has multiple regional beams covering different parts of India - five Ku-band transponders with spot beams covering northern, north-eastern, eastern, southern and western regions of the country, a Ku-band transponder with its footprint covering the Indian mainland region and six C-band transponders with their footprints covering the entire country. EDUSAT is being implemented in three phases, pilot, semi-operational and operational phases. While pilot phase has continued, semi-operational and operational phase have been put into implementation also.

EDUSAT is already providing a wide range of educational delivery modes like one-way TV broadcast, interactive TV, video conferencing, computer conferencing, web-based instructions, etc.

Sixty four networks have been setup so far, out of which 10 networks use national Ku-band beam and 36 networks are operational on regional Ku-band and Extended-C band national beams. There are more than 3386 interactive classrooms and 31313 receive only classrooms totaling close to 34699 classrooms. Networks have already been setup in 24 states covering almost entire country including all islands (Andaman & Nicobar, Lakshdweep), North-Eastern states and Jammu & Kashmir. Implementation in remaining states is under progress.

Special Networks

One of the innovative networks on EDUSAT is the network for "Blind schools". Blind People's Association, Ahmedabad is a leading organisation promoting education, training, employment and rehabilitation for blind persons. Considering the specific needs of the blind people, an altogether different kind of broadcast network configuration delivering live audio and data which is read by blind person through its printed impression (Braille) was set up.

Another special network in Ext C-band connecting 50 engineering institutes across the country has been established to impart teaching by distinguished Professors/Faculty from top 21 Universities in USA who would visit India to conduct eight-week courses in various subjects in engineering. This network is now shared by IIT-Bombay network with additional 30 end users.

Apart from this, network for IIM, Bangalore connecting with its other centre in Chennai; an extended C-band network connecting all the five centres of National Council of Science Museums for promoting scientific temperament among students and general public; network for Mahabharata Sansthan for online transmission

of digitised manuscripts from remote areas through mobile terminal to centralised centre for archival so as to preserve them; two networks in Kerala for imparting education and awareness to parents and teachers of mentally challenged children schools; network in Tamilnadu and Puducherry connecting centres of Aravind Virtual Academy for providing eye-care; etc. are a few special networks, which have been set up/ under implementation under EDUSAT Utilisation Programme.

Educational TV Services

INSAT is being used to provide Educational TV (ETV) service for primary school children in Tamil, Marathi, Oriya, Telugu and Hindi. A general enrichment programme on higher education (college sector) is telecast on the national network. These programmes, provided by the University Grants Commission (UGC), are a part of its countrywide classroom programme. The Indira Gandhi National Open University (IGNOU) broadcasts half an hour curriculum based lectures daily via the national network for the students.

Training and Developmental Communications Channel (TDCC)

A total of 8 Ext. C-band channels - 6 on INSAT-3B and 2 on Edusat - are being used for Training, Development and Communication Channel (TDCC), a service that has been operational since 1995. It provides 1-way video & 2-way audio system of interactive education. The teaching-end includes a studio and an uplink facility for transmitting live or pre-recorded lectures. The participants at the classrooms located nationwide receive lectures through simple dish antennas (DRS) and have facility to interact with lecturers using telephone lines.

Several state governments and universities are using the TDCC system extensively for Distance Education, Rural Development, Women & Child Development, Panchayati Raj, Health, Agriculture, Forestry, etc. The teaching-ends are now available at Gujarat, Madhya Pradesh, Orissa, Karnataka and Goa. The DRS network consists of more than 5000 classrooms spread over the country.

b) Telemedicine Programme

It is an innovative process of synergising benefits of Satellite communication technology and information technology with Biomedical Engineering and Medical Sciences to deliver the healthcare services to the remote, distant and underserved regions of the country.

Providing healthcare to India's over one billion population of which about 75 per cent live in villages, is a formidable task. About 75 per cent of the doctors practice in urban areas and 23 percent in semi-urban areas. This leaves just 2 per cent of the qualified doctors, who are attached to about 23,000 primary health and 3000 community health centres, to attend to 70 per cent of the population living in villages.

ISRO's telemedicine pilot project was started in the year 2001 with the aim of introducing the telemedicine facility to the grass root level population as a part of proof of concept technology demonstration. The telemedicine facility connects the remote District Hospitals/ Health Centres with Super Speciality Hospitals in cities, through the INSAT Satellites for providing expert consultation to the needy and underserved population.

Telemedicine initiatives at ISRO have been broadly divided into the following areas:

- Providing Telemedicine Technology & connectivity between remote/rural hospital and Super Speciality Hospital for Teleconsultation, Treatment & Training of doctors & paramedics.
- Providing the Technology & connectivity for Continuing Medical Education (CME) between Medical Colleges & Post Graduate Medical Institutions/Hospitals.
- Providing Technology & connectivity for Mobile Telemedicine units for rural health camps especially in the areas of ophthalmology and community health.
- Providing technology and connectivity for Disaster Management Support and Relief.

Presently, ISRO's Telemedicine Network has enabled 382 Hospitals with the Telemedicine facility. 306 Remote/Rural/District Hospital/ Health Centres and 16 Mobile Telemedicine units are connected to 60 Super Speciality Hospitals located in the major cities. The mobile vans are extensively used for tele-ophthalmology, diabetic screening, mammography, childcare and

community health. The Mobile Teleopthalmology facilities provide services to the rural population in ophthalmology care, including village level eye camps, vision screening for Cataract /Glaucoma / Diabetic Retinopathy.

The telemedicine facilities are established at many remote rural district hospitals in many states and union territories of the country, including Jammu & Kashmir, Andaman & Nicobar Islands, Lakshadweep Islands, North Eastern States etc. State level telemedicine networks are established in Karnataka, Kerala, Rajasthan, Maharashtra, Orissa and Chhattisgarh. Many interior districts in Orissa, Madhya Pradesh, Andhra Pradesh, Punjab, West Bengal and Gujarat have the telemedicine facility. About 1.5 Lakh patients are getting the benefits of Telemedicine every year.

c) Television

INSAT has been a major catalyst for the expansion of television coverage in India. Satellite television now covers 100% area as well as population. The terrestrial coverage is over 65 percent of the Indian land mass and over 90 percent of the population. At present 40 Doordarshan TV channels including news uplinks are operating through C-band transponders of INSAT-3A, INSAT-4B, INSAT-3C and INSAT-2E (Additionally IS-10 & IS-906 INTELSAT leased). All of the Satellite TV channels are digitalized.

The following satellite television services are being operated by Doordarshan:

- National networking service (DD-1), DD News (DD-2), DD-Sports, DD-Urdu, DD-India DD-Bharati.
- Regional services in Sates of Kerala, Karnataka, Jammu & Kashmir, Tamil Nadu, West Bengal, Andhra Pradesh, Gujarat, UP, Assam, Maharashtra, Punjab, Himachal Pradesh, Rajasthan, Tripura, Orissa, Bihar, Madhya Pradesh, Uttarakhand (Uttaranchal), Haryana, Mizoram, Jharkhand and Chhatisgarh.

As on Dec. 2008, 1412 transmitters of Doordarshan are working in INSAT system out of which 1133 transmitters (130 High Power Transmitters (HPT), 728 Low Power Transmitters (LPT), 257 Very Low Power Transmitters (VLPT) and 18 Transposers) are working in the DD-1 network and 167 TV Transmitters (73 HPTs, 78 LPTs and 16 VLPTs) are working in the DD-News network. 108 Regional service transmitters (6 HPTs, 8 LPTS and 94 VLPTs), 4 HPTs with digital transmissions are also operational in the Doordarshan Network. Out of these 4 transmitters, one is located at Delhi and is carrying 16 mobile TV services for experimental purpose. 45 DD and Private TV channels are operational through DTH service ("DD Direct+"). 10 channel DTH planned in C-Band for Andaman & Nicobar islands is under installation.

INSAT provides bandwidth for DTH broadcasting service over Indian region. At present DTH service is operational through INSAT- 4 series. INSAT-4 series has high power transponders with 52 dBW EIRP (EOC) to support DTH service with 60/90 cm dish of TVRO at receiving side, all over India.

TATA-SKY operates DTH service through INSAT-4A at 83 deg. East with total number of 150 video channels. Doordarshan (DD-DIRECT) operates DTH service through INSAT-4B at 93.5 deg East with total number of 48 channels which are free to air. Other private DTH service providers like Sun Direct and Bharati Airtel have also started DTH service through INSAT-4B and INSAT-4CR which is at 74 deg. East location.

In all, around 16.2 millions of TVROs are distributed and operational all over India by various service providers, including DD DIRECT TVRO's number in excess of 10 millions.

d) Satellite Aided Search and Rescue

India is a member of the international COSPAS-SARSAT programme for providing distress alert and position location service through LEOSAR (Low Earth Orbit Search And Rescue) satellite system. Under this programme, India has established two Local User Terminals (LUTs), one at Lucknow and the other at Bangalore. The Indian Mission Control Centre (INMCC), of ISRO is located at ISTRAC, Bangalore.

INSAT-3A located at 93.5 deg. East is equipped with 406 MHz Search and Rescue payload that picks up and relays alert signals

originating from the distress beacons of maritime, aviation and land users. INSAT and GOES systems have become an integral part of the COSPAS-SARSAT system and they complement the LEOSAR system.

Indian LUTs provide coverage to a large part of Indian Ocean region rendering distress alert services to Bangladesh, Bhutan, Maldives, Nepal, Seychelles, Sri Lanka and Tanzania. The operations of INMCC/LUT are funded by the participating agencies, namely, Coast Guard, Airports Authority of India (AAI) and Director General of Shipping and Services.

INSAT GEOSAR Local User Terminal (GEO LUT) is established at ISTRAC, Bangalore and integrated with INMCC. The distress alert messages concerning the Indian service area, detected at INMCC are passed on to Indian Coast Guard and Rescue Coordination Centres at Mumbai, Kolkata, Delhi and Chennai. The search and rescue activities are carried out by Coast Guard, Navy and Air Force. INMCC is linked to the RCCs and other International MCCs through Aeronautical Fixed Telecommunication Network (AFTN). The Indian LUTs and MCC provide service round the clock and maintain the database of all 406 MHz registered beacons equipped on Indian ships and aircraft.

Development of indigenous search and rescue beacons has been completed, and is now in qualification phase. Shortly it will be released to the Indian fishermen community.

Till date, there are about 400 registered user agencies (Maritime & Aviation) in India with more than 5200 radio beacons in use.

Migration from LEOSAR & GEOSAR to MEOSAR system has been under taken. Design of upcoming MEOSAR system is ready and will be implemented in 2 years.

e) Disaster Management

The Disaster Management Support (DMS) Programme of ISRO, provides timely support and services from aero-space systems, both imaging and communications, towards efficient management of disasters in the country. The DMS programme addresses disasters such as flood, cyclone, drought, forest fire, landslide and Earthquake. These include creation of digital data base for facilitating hazard zonation, damage assessment, etc., monitoring of major natural disasters using satellite and aerial data; development of appropriate techniques and tools for decision support, establishing satellite based reliable communication network, deployment of emergency communication equipments and R&D towards early warning of disasters.

"To support the total cycle of disaster/ emergency management for the country, in near real time, the database creation is addressed through National Database for Emergency Management (NDEM), a GIS based repository of data. NDEM is envisaged to have core data, hazard-specific data, and dynamic data in spatial as well as aspatial form.

Airborne ALTM-DC data acquisition is being carried out for the flood prone basins in the country. The development of flight model of C band DMSAR is nearing completion. SAR data was acquired over selected basins using Development model of DMSAR. Towards providing emergency communication for disaster management activities, and at the behest of Ministry of Home Affairs (MHA), ISRO has set up a satellite based Virtual Private Network (VPN) linking the National Control Room at MHA with DMS-DSC at NRSC, important national agencies, key Government Offices in Delhi and the Control Rooms of 22 multi-hazard-prone States. Further ISRO has developed and deployed INSAT Type-D terminals (portable satellite phones), INSAT based Distress Alert Transmitter (DAT) for fishermen, Cyclone Warning Dissemination System (CWCS) and DTH based Digital Disaster Warning System (DDWS) in disaster prone areas.

As part of R&D support to DMS for remote sensing applications, work on Tropical Cyclone Track intensity and landfall prediction, Earthquake Precursor studies, Coastal Vulnerability mapping and Early Warning of Landslides are being carried out.

The DMS programme is also supporting the many international initiatives by sharing data and information. Through International Charter "Space and Major Disasters" and Sentinel Asia (SA) initiative for supporting disaster management activities in the Asia-Pacific region, ISRO is providing IRS datasets and other information for use during major calamities.

RECENT SATELLITES

- **INSAT-3D:**

It was launched on July 26, 2013, is an advanced weather satellite of India configured with improved Imaging System and Atmospheric Sounder. INSAT-3D is designed for enhanced meteorological observations, monitoring of land and ocean surfaces, generating vertical profile of the atmosphere in terms of temperature and humidity for weather forecasting and disaster warning.

It carries four payloads —

- 6 channel multi-spectral Imager
- 19 channel Sounder
- Data Relay Transponder (DRT)
- Search and Rescue Transponder

The payloads of INSAT-3D will provide continuity and further augment the capability to provide various meteorological as well as search and rescue services.

- **GSAT-10:**

India's advanced communication satellite, GSAT-10, is a high power satellite being inducted into the INSAT system. It was launched on September 29, 2012. Weighing 3400 kg at lift-off, GSAT-10 is configured to carry 30 communication transponders in normal C-band, lower extended C-band and Ku-band as well as a GPS Aided GEO Augmented Navigation (GAGAN) payload operating in L1 and L5 bands. GSAT-10 is the second satellite to carry GAGAN payload after GSAT-8, which is already providing navigation services from orbit. GSAT-10 also carries a Ku-band beacon to help in accurately pointing ground antennas towards the satellite.

The 30 communication transponders onboard GSAT-10 will further augment the capacity in the INSAT system. The GAGAN payload provides the Satellite Based Augmentation System (SBAS), through which the accuracy of the positioning information obtained from the GPS satellites is improved by a network of ground based receivers and made available to the users in the country through geo-stationary satellites.

- **GSAT-12**

GSAT-12, the latest communication satellite built by ISRO, weighs about 1410 kg at lift-off. GSAT-12 is configured to carry 12 Extended C-band transponders to meet the country's growing demand for transponders in a short turn-around-time. It was launched on July 15, 2011. The 12 Extended C-band transponders of GSAT-12 will augment the capacity in the INSAT system for various communication services like Tele-education, Telemedicine and for Village Resource Centres (VRC).

- **GSAT-8**

It is a high power communication satellite inducted in the INSAT system. Weighing about 3100 Kg at lift-off, GSAT-8 is configured to carry 24 high power transponders in Ku-band and a two-channel GPS Aided Geo Augmented Navigation (GAGAN) payload operating in L1 and L5 bands. It was launched on May 21, 2011. The 24 Ku band transponders will augment the capacity in the INSAT system. The GAGAN payload provides the Satellite Based Augmentation System (SBAS), through which the accuracy of the positioning information obtained from the GPS Satellite is improved by a network of ground based receivers and made available to the users in the country through the geostationary satellites.

- **GSAT-5P**

GSAT-5P was the fifth satellite launched in the GSAT series and launched on December 25, 2010. It is an exclusive communication satellite to further augment the communication services currently provided by the Indian National Satellite (INSAT) System. Weighing 2310 kg at lift-off, GSAT-5P carried 24 Normal C-band and 12 Extended C-band transponders.

- **GSAT-4**

GSAT-4 was the nineteenth geo-stationary satellite of India built by ISRO and fourth in the GSAT series, launched on April 15, 2010. GSAT-4 was basically an experimental satellite. However, GSAT-4 was not placed in orbit as GSLV-D3 could not complete the mission.

- **INSAT–4CR**

This spacecraft is configured with exclusive Ku band employing the I-2K Bus with a mass of

2130 Kg. It was injected on September 2, 2007 into the orbit by GSLV-F04 rocket with enhanced Russian Cryogenic engine and co-located at 74° East longitude along with INSAT–3C / Kalpana–1 / GSAT–3 (EDUSAT). INSAT-4CR carries 12 high-power Ku-band transponders designed to provide Direct-to-home (DTH) television services, Video Picture Transmission (VPT) and Digital Satellite News Gathering (DSNG).

- **INSAT–4B**

This spacecraft is the second in the INSAT 4 series of spacecrafts and is configured with exclusive communication payloads to provide services in Ku and C frequency bands. This is co-located with INSAT–3A at 93.5°E longitude and was launched on March 12, 2007.

INDIAN REMOTE SENSING SYSTEM

Over a span of three decades, the space borne remote sensing capabilities have grown to such an extent that space-based observation has become the prime source of information on earth's resources and its environment. The Indian Remote Sensing (IRS) satellites are the mainstay of National Natural Resources Management System (NMRMS), for which department of space is the nodal agency, providing operational remote sensing data services. It essentially involves measuring the electromagnetic radiation of the sun that is reflected, scattered or re-emitted by the objects on the surface of the earth.

Starting with IRS-1A in 1988, ISRO has launched many operational remote sensing satellites into orbit. Today, India has one of the largest constellations of remote sensing satellites in operation. Currently, ten operational satellites are in orbit – RESOURCESAT-1 and 2, CARTOSAT-1, 2, 2A, 2B, RISAT-1 and 2, OCEANSAT-2 and Megha-Tropiques. While RESOURCESAT-1, CARTOSAT-1 and 2 have successfully completed their designed mission life in orbit, they continue to provide limited services to the users. Varieties of instruments have been flown onboard these satellites to provide necessary data in a diversified spatial, spectral and temporal resolutions to cater to different user requirements in the country and for global usage. With such satellites in orbit and considering the plans of the near future, such as INSAT-3D during 2013, the Indian Earth Observation System has setup its own niche to provide high quality data products and services for national development.

Remote sensing applications

Remote sensing has enabled mapping, studying, monitoring and management of various resources like agriculture, forestry, geology, water, ocean, etc. It has further enabled monitoring of environment and thereby helping in conservation. In the last four decades it has grown as a major tool for collecting information on almost every aspect on the earth. With the availability of very high spatial resolution satellites in the recent years, the applications have multiplied. In India remote sensing has been used for various applications during the last four decades and has contributed significantly towards development.

India has its own satellites like Indian Remote Sensing Satellite (IRS) series - Resourcesat, Cartosat, Oceansat, etc. which provide required data for carrying out various projects. Some of the important projects carried out in the country include Groundwater Prospects Mapping under Drinking Water Mission, Forecasting Agricultural output using Space, Agrometeorology and Land based observations (FASAL), Forest Cover/Type Mapping, Grassland Mapping, Biodiversity Characterisation, Snow & Glacier Studies, Land Use/Cover mapping, Coastal Studies, Coral and Mangroves Studies, Wasteland Mapping etc. The information generated by large number of projects have been used by various departments, industries and others for different purposes like development planning, monitoring, conservation, etc.

a) Groundwater Prospects and Recharge Zone Mapping

The occurrence and movement of groundwater is mainly controlled by many factors such as rock types, landforms, geological structures, soil, land use, rainfall, etc. Remote sensing based groundwater prospect zone map serves as a base for further exploration using hydro geological and geophysical methods to locate well sites. Studies have shown that if remote sensing data are used at first level to delineate prospective zones and further followed

up by hydro geological and geophysical surveys, higher success could be achieved besides savings in terms of cost, time and work. Further remote sensing data helps in identifying suitable areas for recharging ground water. Under Rajiv Gandhi National Drinking Water Mission, funded by the Department of Drinking Water Supply of the Ministry of Rural Development, ground water prospects and recharge zone maps on 1:50,000 scale was taken up by ISRO in phases using IRS data. So far, 14 states (Andhra Pradesh (Part), Madhya Pradesh, Rajasthan, Karnataka, Kerala, Chattisgarh, Gujarat, Orissa, Himachal Pradesh, Jharkhand, Assam, Punjab, Uttarakhand and Uttar Pradesh (Part) have been completed and the maps have been provided to State Ground Water Departments and other concerned departments. The maps have been used for locating well sites and recharge structures. The feedback shows that about 275,800 wells have been drilled with more than 90% success rate and about 9000 recharge structures have been constructed. The work is under progress for the states of Jammu & Kashmir, Maharashtra, Uttar Pradesh-Part, West Bengal-Part, Haryana and Arunachal Pradesh.

b) Wetlands

The primary objective of this project is to map the wetlands of India (natural, manmade, coastal and inland) at 1:50,000 scale and create a database with a query shell. This project has been taken up at the specific request of Ministry of Environment and Forests (MoEF). Digital analysis of two date (pre and post monsoon) satellite data is used for the purpose. This is the first time that country will have country specific classification system, updated database and map of wetlands at 1:50,000 scale which will help in conservation / preservation plan, water resources plan, methane emission study etc. Atlas of 7 states (Goa, Meghalaya, Manipur, Delhi, Arunachal Pradesh, A&N islands, Lakshadweep islands) had been completed and released by Hon'ble Minster for Environment and Forests on Feb 2, 2010.

c) National Urban Information System (NUIS)

The 74th Constitution Amendment Act - 1992 and more specifically under the 12th Schedule of Municipal Functions envisages among others, the preparation of spatial plans for economic development and social justice for all urban areas. Considering the same, National Urban Information System (NUIS) is approved as National Mission Programme of Ministry of Urban Development (MUD, GOI). NUIS comprises of broadly two major components - (a) Urban Spatial Information System (USIS) to meet the Spatial (maps / images) data / information requirements of urban planning and management functions, (b) National Urban Data Bank & Indicators (NUDB&I) to develop town-level urban database to support development of indices through a network of Local Urban Observatories (LUOs) under the National Urban Observatory (NUO) Programme.

Under USIS of NUIS a comprehensive 3-tier GIS database for each town / city to support the urban planning and management is envisaged:

- Generate 1:10,000 scale GIS-compatible spatial information from IRS images and integrate attribute information to enhance Master Plan / Development Plan of urban settlements
- Generate 1:2,000 scale GIS-compatible spatial information from aerial photographs and integrate attribute information to enhance Municipal Plan / Zonal Plan and detailed Town Planning schemes.
- Establish a 1:1000 scale utilities GIS using Ground Penetrating Radar data on a pilot basis to include water-supply, sewerage, power and communication for Utilities Planning and Management.

DOS is participating in the endeavor of NUIS taken up under NNRMS Standing Committee on Urban development. Apart from providing IRS satellite data and aerial photography, DOS shares the responsibility of the preparation of thematic maps at 1:10,000 scale. In Phase-I, 158 towns covering geographical area of around 55,755 sq km has been taken up. As a pilot project, thematic mapping for the Korba town located in Chattisgarh State covering 276 sq km. has been completed. About 75 towns had been completed during 2009 and planned to complete the remaining towns soon thereafter.

d) National Natural Resource Management System

The Indian remote sensing programme is

intended to be a key element of India's ambitious National Natural Resource Management System (NNRMS). NNRMS was established in 1983 and is supported by Planning Commission, Government of India. Department of Space (DOS) is the nodal agency for implementing NNRMS in the.

The NNRMS with its headquarters in Bengaluru is functioning with the main objective of liaising with different users of the State / Central Government departments / organisations in different tasks related to the use of remote sensing data, such as, the establishment of infrastructure for remote sensing centre / unit / cell, supply of equipment for data processing and analysis, organising the information system for the remote sensing data in management of natural resources in the country. In doing so, NNRMS adopts various advanced technologies of satellite and aerial remote sensing; Geographical Information Systems (GIS); precise Positioning Systems; database and networking infrastructure and advanced ground-based survey techniques.

The three major components of NNRMS are:

(a) application projects,
(b) infrastructure and manpower development, and
(c) establishing a National Natural Resources Information System (NNRIS).

The applications project will be in major resource sectors such as agriculture, land use, water resources, forestry, geology, marine resources and environment.

DOS / ISRO is the lead agency for a significant number of application projects. These projects are being executed in collaboration with a large number of State and Central Government agencies. Major contributions in the disciplines of soil, vegetation mapping and mineral targeting will be made from the National Bureau of Soil Survey and Land Use Planning / ICAR, Forest Survey of India (Ministry of Environment and Forests) and Geological Survey of India (GSI), respectively.

Five Regional Remote Sensing Service Centres (RRSSCs) are being set up for processing remote sensed data. The Dehradun and Bengaluru centres are already operational. The centres at Nagpur, Kharagpur, and Jodhpur are underway. Another centre for the north-eastern region is planned. DOS will manage these regional centres initially. The backbone of the RRSSCs as well as the associate centres is a digital image analysis system primarily for handling satellite acquired terrain multispectral data.

INTRODUCTION OF SOME LATEST SATELLITES

(a) BHUVAN

Bhuvan is an initiative to showcase this distinctiveness of India's imaging capabilities, including the thematic information derived from such imagery which could be of vital importance to a common man with a focus on Indian region. Bhuvan, an ambitious project of ISRO to take Indian images and thematic information in multiple spatial resolutions to people through a web portal through easy access to information on basic natural resources in the geospatial domain. Bhuvan showcases Indian images by the superimposition of these IRS satellite imageries on 3D globe. It displays satellite images of varying resolution of India's surface, allowing users to visually see things like cities and important places of interest looking perpendicularly down or at an oblique angle, with different perspectives and can navigate through 3D viewing environment. The degree of resolution showcased is based on the points of interest and popularity, but most of the Indian terrain is covered upto at least 5.8 metres of resolution with the least spatial resolution being 55 metres from AWiFs Sensor. With such rich content, Bhuvan opens the door to graphic visualisation of digital geospatial India allowing individuals to experience the fully interactive terrain viewing capabilities.

Multi-resolution images from multi-sensor IRS satellites of India is seamlessly depicted through the Bhuvan web portal by enabling a common man to zoom into specific area of interest at high resolution. Bhuvan brings a whole lot of uniqueness in understanding our own natural resources whilst presenting beautiful images and thematic vectors generated from varieties of geospatial information. Bhuvan will also attempt to bring out the importance of multi-temporal data and to highlight the changes taking place to our natural resources, which will

serve as a general awareness on our changing planet. There are lot more special value added services which will be enabled onto the web portal in due course of time and each one of those services are going to be unique in preserving and conserving our precious natural resources through public participation. We are sure the common man will get rich benefits from these Indian geospatial data services in days to come.

Bhuvan Geoportal entered its fourth year of operations in August 2012. During this period, Bhuvan has evolved both in terms of the content and features besides speed and access. The portal had an average of 19,000 visitors per month during the last one year. In addition to visualisation, Bhuvan has been providing satellite data and products with 23 m and coarser spatial resolution and older than 2 years. Besides, several information products like CartoDEM, OCM based Normalised Difference Vegetation Index (NDVI) and Vegetation, Fraction products, Tropical Cyclone Heat Potential, etc., are being provided as free downloads through NRSC Open Earth Observation Data Archive (NOEDA) since September 2011.

Basic Features of Bhuvan

- Access, explore and visualise 2D and 3D image data along with rich thematic information on Soil, wasteland, water resources, etc.
- Visualise multi-resolution, multi-sensor, multi-temporal image data.
- Superpose administrative boundaries of choice on images as required
- Visualisation of AWS (Automatic Weather Stations) data/information in a graphic view and use tabular weather data of user choice.
- Fly to locations (Fly from the current location directly to the selected location)
- Heads-Up Display (HUD) navigation controls (Tilt slider, north indicator, opacity, compass ring, zoom slider)
- Navigation using the 3D view Pop-up menu (Fly-in, Fly out, jump in, jump around, view point)
- 3D Fly through (3D view to fly to locations, objects in the terrain, and navigate freely using the mouse or keyboard)
- Drawing 2D objects
- Drawing 3D Objects
- Snapshot creation (copies the 3D view to a floating window and allows to save to an external file)
- Measurement tools (Horizontal distance, aerial distance, vertical distance, measure area)
- Shadow Analysis (it sets the sun position based on the given time creating shadows and effects the lighting on the terrain)
- Urban Design Tools (to build roads, junctions and traffic lights in an urban setting)
- Contour map (Displays a colourized terrain map and contour lines)
- Draw tools (Creates simple markers, free hand lines, urban designs)

(b) YOUTHSAT

It is a joint Indo-Russian stellar and atmospheric satellite mission with the participation of students from Universities at graduate, post graduate and research scholar level. With a lift-off mass of 92 kg, Youthsat is a mini satellite and the second in the Indian Mini Satellite (IMS) series. Youthsat mission intends to investigate the relationship between solar variability and thermosphere-Ionosphere changes. The satellite carries three payloads, of which two are Indian and one Russian. Together, they form a unique and comprehensive package of experiments for the investigation of the composition, energetics and dynamics of earth's upper atmosphere. “

The Indian payloads are:

1. **RaBIT** (Radio Beacon for Ionospheric Tomography) - For mapping Total Electron Content (TEC) of the Ionosphere.
2. **LiVHySI** (Limb Viewing Hyper Spectral Imager) - To perform airglow measurements of the Earth's upper atmosphere (80- 600 km) in 450-950 nm.

The Russian payload is:

SOLRAD - To study temporal and spectral parameters of solar flare X and gamma ray fluxes as well as charge particles in the earth polar cap regions.

(c) RESOURCESAT-2

It is a follow on mission to RESOURCESAT-1 and the eighteenth Remote Sensing satellite built by ISRO. RESOURCESAT-2 is intended to continue the remote sensing data services to global users provided by RESOURCESAT-1, and to provide data with enhanced multispectral and spatial coverage as well. ""Important changes in RESOURCESAT-2 compared to RESOURCESAT-1 are: Enhancement of LISS-4 multispectral swath from 23 km to 70 km and improved Radiometric accuracy from 7 bits to 10 bits for LISS-3 and LISS-4 and 10 bits to 12 bits for AWIFS. Besides, suitable changes, including miniaturisation in payload electronics, have been made in RESOURCESAT-2.

RESOURCESAT-2 also carries an additional payload known as AIS (Automatic Identification System) from COMDEV, Canada as an experimental payload for ship surveillance in VHF band to derive position, speed and other information about ships.

RESOURCESAT-2 carries two Solid State Recorders with a capacity of 200 Giga Bytes each to store the images taken by its cameras which can be read out later to ground stations.

(d) JUGNU

The nanosatellite Jugnu weighing 3 kg is designed and developed by Indian Institute of Technology, Kanpur under the guidance of ISRO. The satellite is intended:

- To prove the indigenously developed camera system for imaging the Earth in the near infrared region and test image processing algorithms.
- Evaluate GPS receiver for its use in satellite navigation.
- Test indigenously developed MEMS based Inertial Measurement Unit (IMU) in space.

(e) SRMSat

The nanosatellite SRMSat weighing 10.9 kg is developed by the students and faculty of SRM University attempts to address the problem of Global warming and pollution levels in the atmosphere by monitoring Carbon dioxide (CO2) and water vapour (H2O). The satellite uses a grating Spectrometer, which will observe absorption spectrum over a range of 900nm - 1700nm infrared range.

(f) Megha-Tropiques

Megha-Tropiques is an Indo-French Joint Satellite Mission for studying the water cycle and energy exchanges in the tropics. The main objective of this mission is to understand the life cycle of convective systems that influence the tropical weather and climate and their role in associated energy and moisture budget of the atmosphere in tropical regions.

Megha-Tropiques will provide scientific data on the contribution of the water cycle to the tropical atmosphere, with information on condensed water in clouds, water vapour in the atmosphere, precipitation, and evaporation. With its circular orbit inclined 20 deg to the equator, the Megha-Tropiques is a unique satellite for climate research that should also aid scientists seeking to refine prediction models.

"Megha-Tropiques carries the following four payloads:

- **Microwave Analysis and Detection of Rain and Atmospheric Structures (MADRAS),** an Imaging Radiometer developed jointly by CNES and ISRO
- **Sounder for Probing Vertical Profiles of Humidity (SAPHIR),** from CNES
- **Scanner for Radiation Budget (ScaRaB),** from CNES
- **Radio Occultation Sensor for Vertical Profiling of Temperature and Humidity (ROSA),** procured from Italy.

(g) Chandrayaan – I

Chandrayaan-1 spacecraft was launched from the Satish Dhawan Space Centre, SHAR, Sriharikota by PSLV-XL (PSLV-C11) on 22 October 2008 in an highly elliptical initial orbit (IO) with perigee (nearest point to the Earth) of 255 km and an apogee (farthest point from the Earth) of 22,860 km, inclined at an angle of 17.9 deg to the equator. Chandrayaan-I mission was abandoned in August 2009 when the spacecraft lost radio contact.

Chandrayaan-1 is India's first and the world's 68th mission to the moon. The world's first moon mission was by the then Union of Soviet Socialist Republics (USSR) on Jan 2, 1959, followed two months later by the US on March 3. Between them, the two countries have sent 62 missions to probe the moon with the US

stealing a march over the then cold war rival USSR by landing a man on the moon on July 20, 1969.

Japan broke the monopoly of the two superpowers on Jan 24, 1990 by sending its spacecraft Hiten to orbit the moon. The European Space Agency launched its probe in September 2003. China sent its spacecraft Chang'e II in 2012.

The first hard landing on the moon was on Sep 12, 1959 by Soviet Union's Luna 2. The first photos from the moon were taken by Oct 4, 1959 from the Soviet spacecraft Luna 3.

On Jan 26, 1962, the US Ranger 3 missed the Moon by 36,793 km. The Soviet Union's Luna 6 did worse on June 8, 1965 missing the moon by 160,000 km. Luna 9 made up for it on Jan 31, 1966 by becoming the first spacecraft to soft land on the moon.

The Indian mission to the moon was proposed at a meeting of the Indian Academy of Sciences in 1999.

Space Craft

- The Chandrayaan-1 spacecraft was cuboid in shape, weighed 1,304 kg at launch and 590 kg at lunar orbit. It carried 11 payloads, including six from abroad.
- A canted single-sided solar array generates required power for the spacecraft during its two-year mission. The solar array generates 700 watts of peak power. During eclipse the spacecraft powered by Lithium ion (Li-Ion) batteries.
- The spacecraft employs an X-band, 0.7-metre diameter parabolic antenna for payload data transmission.
- The Telemetry, Tracking & Command (TTC) communication is in S-band frequency and scientific payload data transmission in X-band frequency.
- The spacecraft has three Solid State Recorders (SSRs) to record data from various payloads.
- SSR-1 helps store science payload data and has capacity of storing 32 GB data.
- The 8 GB SSR-2 will store science payload data along with spacecraft altitude information, satellite housekeeping and other auxiliary data.
- The third SSR with 10 GB SSR is for storing M3 (Moon Mineralogy Mapper) payload data.
- On the ground, Chandrayaan-1 was tracked by the Deep Space Station (DSN), Spacecraft Control Centre (SCC) and Indian Space Science Data Centre (ISSDC).

India had hosted six foreign instruments in its maiden moon odyssey Chandrayaan-I — three from ESA, two from NASA and one from Bulgaria. Chandrayaan-I carried India's five instruments.

Scientific Objectives

The Chandrayaan-1 mission was aimed at high-resolution remote sensing of the moon in visible, near infrared (NIR), low energy X-rays and high-energy X-ray regions. Specifically the objectives are:

- To prepare a three-dimensional atlas (with high spatial and altitude resolution of 5-10 m) of both near and far side of the moon.
- To conduct chemical and mineralogical mapping of the entire lunar surface for distribution of mineral and chemical elements such as Magnesium, Aluminum, Silicon, Calcium, Iron and Titanium as well as high atomic number elements such as Radon, Uranium & Thorium with high spatial resolution.
- The Simultaneous photo geological, mineralogical and chemical mapping through Chandrayaan-1 mission will enable identification of different geological units to infer the early evolutionary history of the Moon. The chemical mapping will enable to determine the stratigraphy and nature of the Moon's crust and thereby test certain aspects of magma ocean hypothesis. This may allow to determine the composition of impactors that bombarded the Moon during its early evolution which is also relevant to the formation of the Earth.

(h) RISAT-1

RISAT 1 (Radar Imaging Satellite 1) is the first satellite imaging mission of ISRO using an active C-band SAR (Synthetic Aperture Radar) imager. The objective of the RISAT mission is to

use the all-weather as well as the day-and-night SAR observation capability in applications such as agriculture, forestry, soil moisture, geology, sea ice, coastal monitoring, object identification, and flood monitoring.

RISAT 1 is developed, manufactured and integrated by ISRO. The Polar Satellite Launch Vehicle (PSLV-C19) successfully launched RISAT-1 on the desired orbit, thus reducing India's dependence on countries like Israel that uses microwave signals to capture images of the earth.

RISAT-1 is a variant of microwave remote sensing satellite (MRSS) and is equipped with synthetic aperture radar payload in the C-band (5.35 GH) frequency. It is better than the previously used optical remote sensing satellites which could capture images during the day only as Optical satellites are relying on sunlight to illuminate the ground below, working much like an ordinary camera does. Radar satellites, on the other hand, send out pulses of radio waves and then pick up signals that bounce back.

During its mission life of five years, the RISAT-1 will use its active microwave remote sensing capability for cloud penetration and day-night imaging of the earth surface and provide critical data inputs for a range of agricultural and soil moisture studies and forestry applications. Among the many tasks the RISAT-1 can perform are paddy monitoring in kharif season, crop estimation and mapping of forestry biomass, besides providing the big picture on natural disasters such as flood and cyclone.

RECENT MISSIONS

a) Space Capsule Recovery Experiment

The Space Capsule Recovery Experiment (SCRE/SRE/SRE-1) was an Indian experimental spacecraft, launched on January 10, 2007 from Sriharikota using the PSLV C7 rocket, along with three other satellites. It remained in orbit for 12 days before re-entering the Earth's atmosphere and splashing down into the Bay of Bengal on January 22. During its reentry, the 555 kg capsule was protected from the intense heat by carbon phenolic ablative material and silica tiles on its outer surface.

The SRE 1 was designed to demonstrate the capability to recover an orbiting space capsule, and the technology of an orbiting platform for performing experiments in microgravity conditions. It was also intended to test reusable Thermal Protection System, navigation, guidance and control, hypersonic aero-thermodynamics, management of communication blackout, deceleration and floatation system and recovery operations.

ISRO is also working on technology to manufacture carbon-carbon composite heat shields, which, along with the silica tiles tested with the SRE, could find use in future reusable spacecraft such as ISRO's planned Reusable Launch Vehicle. During its stay in orbit, the following two experiments on board SRE 1 were successfully conducted under microgravity conditions.

One of the experiments was related to the study of metal melting and crystallization under microgravity conditions. The second experiment was intended to study the synthesis of nano-crystals under microgravity conditions. This was an experiment in designing biomaterials that better replicate natural biological products.

b) SRE-2 Project was formed with the main objective of realising a fully recoverable capsule and to provide a platform to conduct micro-gravity experiments. SRE capsule has four major hardware, namely, Aero Thermo-structure (ATS), Spacecraft platform, deceleration and floatation system and payloads.

The main objective of SRE II is to realize a fully recoverable capsule and provide a platform to conduct microgravity experiments on Micro-biology, Agriculture, Powder Metallurgy, etc. SRE-2 is proposed to be launched onboard PSLV.

c) Mars Orbiter Mission

Mars Orbiter Mission is ISRO's first interplanetary mission to planet Mars with a spacecraft designed to orbit Mars in an elliptical orbit of 372 km by 80,000 km. Mars Orbiter mission is India's next challenging technological mission out of the Earth's gravitational field. The major demands will be critical mission operations and stringent requirements on propulsion, communications and other bus systems of the spacecraft. The primary driving technological objective of the mission is to design and realize a

spacecraft with a capability to reach Mars (Martian transfer Trajectory), then to orbit around Mars (Mars Orbit Insertion) which will take about nine months time.

Yet another technological challenge is to realize related deep space mission planning and communication management at a distance of nearly 400 million km. The polar Satellite Launch Vehicle PSLV will be used to inject the spacecraft from SDSC, SHAR in the 250 X 23000 km orbit with an inclination of 17.864 degree. As the minimum energy transfer opportunity from Earth to Mars occurs once in 26 months, the opportunity in 2013 demands a cumulative incremental velocity of 2.592 km/sec.

Mission to Mars (during November 2013 launch opportunity):

Mars with its many similarities to earth is an important planet to understand the origin and evolution of the solar system. India certainly cannot afford to be behind in its independent exploration of the red planet. India's first Mission to Mars during 2013 would be important more from the technological perspective, namely, entire mission design, planning, management and operations, and communication from a distance of nearly 400 million km. This mission will demonstrate ISRO's capability to undertake deep-space planetary mission where the travel time from earth to Mars is nearly 300 days. The Indian Mission to Mars would also provide an opportunity to the scientific community, to further understand the Martian Science.

The present plan is to launch a Mars-orbiter using PSLV-XL during the November 2013 launch opportunity. Mars-orbiter will be placed in an orbit of 500×80,000 km around Mars and will have a provision for carrying nearly 25 kg of scientific payloads on board. An indicative plan outlay of `39,750 crore at current prices for the Twelfth Five Year has been made for the DOS.

GLOBAL POSITIONING SYSTEM

The Global Positioning System (GPS) is a space-based global navigation satellite system (GNSS) that provides reliable location and time information in all weather and at all times and anywhere on or near the Earth when and where there is an unobstructed line of sight to four or more GPS satellites. It is maintained by the United States government and is freely accessible by anyone with a GPS receiver. GPS was created and realized by the U.S. Department of Defense (USDOD) and was originally run with 24 satellites. It was established in 1973 to overcome the limitations of previous navigation systems.

GPS works in six logical steps:

a) The basis of GPS is "triangulation" from satellites.

b) To "triangulate," a GPS receiver measures distance using the travel time of radio signals.

c) To measure travel time, GPS needs very accurate timing which it achieves with some tricks.

d) Along with distance, you need to know exactly where the satellites are in space. High orbits and careful monitoring are the secret.

e) You must correct for any delays the signal experiences as it travels through the atmosphere.

f) Finally (for us), you can now obtain the precise time from the GPS satellites.

Improbable as it may seem, the whole idea behind GPS is to use satellites in space as reference points for locations here on earth. That's right, by very, very accurately measuring our distance from three satellites we can "triangulate" our position anywhere on earth.

Triangulation-What is it?

a) Position is calculated from distance measurements (ranges) to satellites.

b) Mathematically we need four satellite ranges to determine exact position.

c) Three ranges are enough if we reject ridiculous answers or use other tricks.

d) Another range is required for technical reasons.

Now, we come to the other varieties of Satellite based navigation platforms, though all of them work on the same basic principle but have their own set of satellites being controlled by different 'master-key' i.e. nation/union that owns them. Henceforth, all the powerful nations having strategic geopolitical angle to their existential identity are some way into building their own SATNAV system.

I. GLONASS

Global Navigation Satellite System is a radio-based satellite navigation system operated for the Russian government by the Russian Space Forces. Development on the GLONASS began in the Soviet Union in 1976, with a goal of global coverage by 1991. Beginning on 12 October 1982, numerous rockets launches added satellites to the system until the constellation was completed in 1995. Following completion, the system fell into disrepair with the collapse of the Russian economy. Beginning in 2003, Russia committed to restoring the system and by 2010 it had achieved 100% coverage of Russia's territory. As on July 30, 2013, total satellites in the GLONASS constellation were 29, in which 24 satellites being operational, while one satellite is in maintenance, one in Flight Tests phase and 3 more are spare ones.

II. GALILEO

Galileo is a global navigation satellite system (GNSS) currently being built by the European Union (EU) and European Space Agency (ESA). The •5 billion project is named after the famous Italian astronomer Galileo Galilei. One of the political aims with Galileo is to provide a high-accuracy positioning system upon which European nations can rely independent from the Russian GLONASS and US GPS systems which can be disabled for commercial users in times of war or conflict.

When in operation, it will use the two ground operations centers, one near Munich, Germany, and another in Fucino, Italy and will consist of 30 satellites (27 operational + 3 active spares). The first experimental satellite, GIOVE-A, was launched in 2005 and was followed by a second test satellite, GIOVE-B, launched in 2008. On October 21, 2011, the first two of four operational satellites were launched to validate the system. The next two followed on October 12, 2012, making it possible to test Galileo end-to-end. Once this In-Orbit Validation (IOV) phase has been completed, additional satellites will be launched to reach Initial Operational Capability (IOC) around mid-decade and this will become fully operational by the year 2019.

Quasi-Zenith Satellite System (QZSS)

The Quasi-Zenith Satellite System (QZSS) is a proposed three-satellite regional time transfer system and enhancement for the Global Positioning System that would be receivable within Japan. The first satellite 'Michibiki' was launched on 11 September 2010. Full operational status is expected by 2013, though with the pacifist approach in for a severe change with the new Japanese government belonging to the Centre-left approach, and also the economy growing may be this date can pre-pone.

In March 2013, Japan announced the expansion of the Quasi-Zenith Satellite System from three satellites to four. The $526 million contract with Mitsubishi Electric for the construction of three satellites is slated for launch before the end of 2017.

BEIDOU Navigation System

The BeiDou Navigation System or BeiDou (COMPASS) Navigation Satellite System is a project by China to develop an independent satellite navigation system. It may refer to either one or both generations of the Chinese navigation system. The first BEIDOU system, officially called BEIDOU Satellite Navigation Experimental System, or known as BeiDou-1, consists of 3 satellites and has limited coverage and applications. It has been offering navigation services mainly for customers in China and from neighboring regions since 2000. The second generation of the system known as Compass or BEIDOU-2 will be a global satellite navigation system consisting of 35 satellites, is still under construction.

It became operational in China in December 2011, with 10 satellites in use, and began offering services to customers in the Asia-Pacific region in December 2012 and the global system will be started by 2020. The chief designer of BeiDou navigation system is Sun JIADONG.

India's satellite-based navigation system-GAGAN

A satellite-based navigation system to aid air traffic from Southeast Asia to Africa, including over the high seas in the vast region, has been launched successfully, placing India into a select group of nations which possess such a sophisticated technology. GAGAN or the GPS Aided Geo Augmented Navigation will also help in marine navigation, search and rescue

operations, rail and road transport, survey and mapping as well as precision farming. The system, developed jointly by the Indian Space Research Organisation and Airports Authority of India, would operationalise a satellite-based Indian Flight Information Region in conjunction with all nations from Southeast Asia, Gulf and West Asia and the eastern coast of Africa. It would be based on a satellite constellation consisting of 24 satellites positioned in six earth-centered orbital planes. When commissioned, GAGAN is expected to provide civil aeronautical navigation signals consistent with International Civil Aviation Organization (ICAO) standards based on the Global Navigation Satellite System (GNSS) Panel, as part of the Future Air Navigation System for the aviation sector. Final System Acceptance Test (FSAT) of GAGAN was successfully completed during July 2012. The FSAT results have successfully demonstrated that GAGAN Signals meet the Civil aviation requirements.

Conclusively, we can say that not only geopolitical angles of the post cold war that has engulfed the technical prowess of a nation but in today's world keeping information network secure and secretive has also become important. Reason behind this growing importance of own navigation pattern can be fear of cyber war as we have seen with the stuxnet on the verge of attacking Iranian electric supply lines and its nuclear installations.

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CHRONICLE
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SUPER-CONDUCTIVITY

The flow of electrons is called current and the materials in which the electrons flow is called a conductor. Copper, mercury, aluminium, etc. are good conductors whereas glass, rubber and wood are bad conductors or insulators. Materials that don't conduct electricity better than copper are called semi-conductors.

In a world plagued by energy crisis, the concept of super-conductivity has come about as a boon to mankind. We know that conductors are mediums that allow electricity to flow through them. However, due to the resistance offered by the medium, the current-carrying capacity of the medium is almost reduced to half its capability. It has been known that temperature is a factor that contributes to this resistance, hence, if the temperature of the carrier could be lowered to absolute zero (0K or "–273°C), these carriers could be made super-conductive, because at this temperature they lose all resistance.

It was in the year 1911 that a Dutch physicist Heike Kamerlingh Onnes, discovered 'Super-conductivity'. While studying the variation of electrical resistance of mercury with temperature, he found that at near the absolute zero temperature, the resistance dropped down to a very small value. It was, however, found that this transition to super-conductivity involved more than simply very high or infinite electrical conductivity. The next step towards unfolding the mystery of super-conductivity took place in 1933, when W. Meissner and R. Ochsenfeld found that a super-conductor placed in a magnetic field expelled the field from the interior of the conductor. Later, it was found that superconductivity needed a temperature of 4.2K, which was the point at which helium gas liquifies. Thus, the super-conductive devices had to be submerged in liquid helium. The main bottleneck was the high cost involved in such a process. The discovery of liquid nitrogen as a replacement for liquid helium cut down the costs considerably. It was also found that super-conductive materials like lead, mercury and tin lost their capability as soon as enough current flowed through them to generate magnetic fields. Further research with ceramics, the alloys of oxides of niobium and titanium, proved that these kept their conductivity despite strong magnetic fields. It was in 1973, that Karl Alex Muller of Zurich Laboratory decided to work on metallic oxides called ceramics. Paul C.W. Chu of Houston University found that super-conducting materials got damaged when their temperature was raised to 52K. Hence, he replaced Barium with Strontium which has a smaller atomic structure and he could raise the temperature to 54K. Later, with the use of rare earth element, temperature was raised to 98K.

Today, Thallium, Barium, Calcium, Copper oxide, Bismuth, Strontium, Yttrium are considered the most attractive materials for super-conductivity.

Uses and Applications: Super-conductors have many advantages over normal conductors. These are:

(i) In normal conductors, the energy lost because of resistance is given off as heat which makes the packing of electrical circuits risky. Thus, a super-conductor with no resistance and consequently no heat building is found suitable to pack the circuits tightly.

(ii) They save electricity as energy loss due to resistance offered by conductors is reduced.

(iii) They have ability to generate very powerful fields from relatively small superconducting electromagnets.

(iv) They can create Josephson junction which is capable of detecting minute magnetic fields and also have the advantage of switching 100 times faster.

These magnetic field detectors are called super-conducting quantum interference devices or SQUIDS.

Due to these inherent advantages, super-conductors have been put to a variety of uses:

(i) Super-conductor electromagnets are used to generate extremely powerful magnetic fields which are used in atomic colliders.

(ii) Mass drivers are used to accelerate the object to very high velocities.

(iii) Super-conductors are also used in magneto cardiograms, nuclear magnetic resonance (NMR), magnetic resonance imaging (MRI), etc. These procedures help the medical experts to take detailed images of organs without having to cut open the skin.

(iv) Magnetic levitated trains (M.L.T.) float 4 inches above their tracks and hence no friction is involved which could have limited their speed. These so called 'Bullet Trains' move at very high speed upto 500 mph.

Research in India: Acknowledging the importance of super-conductivity, a Programme Management Group was set up by the Government in 1987. It was soon replaced by the National Super-conductivity Science and Technology Board in 1991. Research work was entrusted to DAE, CSIR and IITs. The areas of research work included improvement in critical temperature, workability of Yitrium, Bismuth, Thalium, QNG and MTMG techniques, SQUIDS, HGMS, etc.

The National Physical Laboratory, New Delhi, has developed a SQUID at liquid Nitrogen temperature of 77K. They will help in geological prospecting and bio-magnetism. Similarly, Super-conducting magnetic ore separators are being used in places like Kudremukh, etc. In yet another field, super-conducting compounds called monophasic compounds with a critical transition temperature of 110 K, 90K and 80K have been obtained. The highest critical transition temperature of 110 K has been reached for the compound bismuth, strontium, calcium and copper oxide. In a major development, Bharat Heavy Electricals Limited, Hyderabad has built and tested the country's first superconducting generator. The generator is cooled by liquid helium and has a capacity of generating 200KV amperes. It has succeeded in cutting down on energy loss, but the use of liquid helium is proving very costly and efforts are on to substitute it with a relatively cheaper liquid Nitrogen.

LASER

The name 'LASER' is an acronym for Light Amplification by Stimulated Emission of Radiation. A 'Laser' is an electric apparatus for producing unified light waves that can be exactly controlled, precisely focused, and when desired, made extremely powerful. It can be aimed precisely enough to destroy a dangerous skin tumour without affecting other healthy skin tissues.

'Laser' light has certain remarkable properties, which make it chromatic, for example, a red laser beam has only red light. Laser is very coherent and can be transmitted over great distances, without the beam spreading. It also has the advantage that a lot of power is concentrated in a very small area. On the other hand, Sunlight, electric light and the light from a candle is incoherent. It is a jumble of different wavelengths and brightness, in what seems to be a steady light emitted in every direction. To produce a coherent beam, the original light has to be coherent, and that's what a laser is for.

Applications: The Laser beams, which are a coherent beam of light and intense enough to vaporise the hardest material ever known, are being used to drill holes in diamond, to weld detached retina of eye and destroy maligant brain tumours located deep inside the brain or in the spinal cord, and to transmit information. Some of the major use of laser beams are :

I. In Consumer Electronics: In the consumer electronics industry, compact discs (CDs) have revolutionised the audio industry with their durability and the fidelity of reproduction. Lasers are an essential part of the recording and reading of Compact Discs (CDs). The recording process is basically similar to that of an LP, except that instead of a needle, laser lights are used to read the

'grooves'. Since the waves are extremely small, the amount of information stored on a CD can be huge, leading to exceptional fidelity.

II. **In Computer Technology:** Computer memories are another area where lasers have had a tremendous impact on ROMs (Read Only Memories). These optical discs allow a far more dense storage of data, which are extremely durable and have a further advantage in having much faster access times for retrieval of data.

III. **In Industries:** The whole edifice of today's industrial society is based on reliable and fast communications. Lasers are playing an extremely vital role in providing data networks.

In clothing factories, computer-guided lasers move across dozens of layers to cloth at a time, cutting material for dozens of suits in a minute. In machine shops, lasers cut through steel much faster than saws or other wedge tools. In a car factory, high-power laser beams spot-weld the parts of a car body together.

Industrial applications of Lasers provide a very concentrated and easily-controlled source of energy. This property finds use in laser welding and drilling, especially where sensitive parts have to be welded and the damage to the surrounding parts is to be minimised.

IV. **Medicine & Health Care:** Laser surgery is becoming increasingly, safe and cheap, thanks to the rapid pace of technical development. One of the earliest medical uses of lasers was in retinal surgery, where detached retinas were fixed. With the development of fibre optics, lasers are being used to 'burn' arterial clots, thus, preventing risky and expensive open-heart surgery.

A wide beam of laser light can be focused to an extremely fine point, thus, producing a very high temperature at that point. This type of tools is called a 'heat knife', which are used by the surgeons to produce self-cauterizing cuts.

V. **In Defence:** Lasers are being used to generate the immense temperatures required to study thermonuclear fusion, and like other technologies, lasers are being conceived as offensive and defensive weapons. In fact, lasers formed one of the main technological mainstays of the Strategic Defence Initiative or Star Wars.

Lasers are used to find the target and to measure the range of targets accurately, fusion process requires a starting temperature of millions of degrees, obtained by concentrated laser beams.

VI. **In Telecommunication:** In a telephone system employing Fibre Optics, voice vibrations are converted into pulses of laser light, thousands of per second. This would be impossible with ordinary light sources, such as, tungsten bulb, which require start-up and cool-down time for each light pulse. Laser light is instantaneous, so millions of pulses can be transmitted in a second. A hair-thin glass fibre can carry several thousand telephone messages at once.

VII. **In cleaning of monuments:** Cleaning by laser, which was introduced in Italy in the 1970s, has until now remained an expensive method with a generally limited performance, mainly consisting of laboratory equipment transported to the site. With the development of Lama (portable laser for the cleaning of facades and historic buildings), however, a decisive step has been taken that could see the widespread adoption of laser-cleaning.

Laser Technology in India

The importance of laser was recognized by the scientific community in India fairly early and several institutions initiated research and development (R&D) projects, although modest ones, in this area in the mid-sixties. Since then, laser-related R&D programmes in India have expanded considerably and now encompasses

most of the Department of Atomic Energy to develop lasers and explore their applications has been quite massive.

Dr. Homi Bhabha, the founder of Indian atomic energy programme, always encouraged research in frontier areas of science, whether or not directly related to the atomic energy programme. Thus, a modest attempt to develop semiconductor lasers at the Bhabha Atomic Research Centre (BARC) was initiated in 1964 though at that time laser was in its infancy and its applications were limited. The first semiconductor laser in India was developed at BARC in 1965. This was a major achievement for India. In another significant breakthrough an optical communication link using Indian-made semiconductor laser was established in 1966 between BARC and the Tata Institute of Fundamental Research (TIFR), a distance of 20 kms. Dr. Bhabha had constantly encouraged this activity and had often visited the laboratories and the site of the optical transmitter to encourage the scientists. Dr. Bhabha's successors continued his policy of encouraging research in frontline science after his tragic death in an air crash in 1967.

The laser-related activity in the Department of Atomic Energy got a fillip in 1987 when a new research institute called Centre for Advanced Technology (CAT) was established. Since its inception, CAT has made commendable progress in both the areas and is widely recognised as an important R&D centre of India.

At present over 90 research institutions are working on various aspects of lasers, like their fabrications, development of laser materials and their applications to various fields like meteorology, communications, medicines, isotope separation and in basic researches. Scientists then started indigenous commercial production of nitrogen, argon, helium, cadmium, and nitrogen pumped dye lasers at various units. BARC has also done extensive work on Go2 lasers.

In the field of semiconductor lasers, which differ from other lasers, works are going on at BARC and Solid State Physics Laboratory, New Delhi. The major centres in India with extensive facilities for development of lasers are BARC, Mumbai, IIT, Kanpur, IIS, Bangalore and BHU, Varanasi. The Tata Institute of Fundamental Research, Mumbai, BARC, Mumbai, IIT, Kharagpur are the centres where theoretical works on lasers or related topics are being carried out.

The Survey of India is making use of lasers in range findings, whereas, for accurate measurement of air pollutants through Rayleigh scattering by Laser Diffractrometer, IIT, Madras has done significant works.

Hence lasers have wide range of applications. But due to limited availability of lasers, their components and cost effectiveness, the activities are still very slow in our country in comparison to other countries.

Laser Development

As the name suggests, Centre for Advanced Technology (CAT) has given priority to developing technologies of important lasers and exploring their application in industry, medicine and R&D. The first laser built at CAT was a copper vapour laser. It is the most powerful laser emitting visible light. Copper vapour lasers capable of giving upto 40 Watt average power had been development at CAT. These lasers are also used to pump tunable dye lasers whose wavelengths can be changed. Several such lasers have been given by CAT to universities and another research laboratories for spectroscopic studies.

Another important laser developed by CAT is the carbon dioxide (CO_2) laser. Incidentally, the CO_2 laser was invented by a well-known Indian scientist, Dr. C.K.N. Patel, who was then working at Bell Labs in USA. CAT has developed technologies of several types of CO_2 lasers namely, low power slow CO_2 laser, high power fast flow CO_2 laser, tunable CO_2 laser and high pressure pulsed CO_2 laser and is also pursuing applications of these CO_2 lasers in medicine and industry. Laser surgery has many advantages over conventional surgery. In laser surgery there is virtually no bleeding, far less trauma to the patients and healing is faster. Although use of laser in surgery is widespread in the western countries, its application in India was limited due to the high cost of imported surgical lasers. CAT therefore decided to develop a surgical laser based on a 60W CO_2. This surgical laser has an articulated arm with seven elbows to allow the

surgeon to guide the laser beam. The laser is designed for Indian conditions and can withstand the extreme ambience. Twelve such lasers have already been supplied to hospitals in India in cities extending from Delhi to Thiruvananthapuram and from Mumbai to Kolkata.

Medical Applications: CAT has also been developing lasers for surgery. It has promoted research in this area in various hospitals through a National Laser Programme. Apart from the surgical CO_2 laser, CAT has developed nitrogen laser for medical use. Nitrogen laser has been found useful for treatment of tuberculosis. Many patients of TB develop cavities in their lungs which become breeding ground of the TB bacillus.

RADAR AND SONAR

RADAR :

It is acronym for Radio Detecting and Ranging. Radar is a technique and apparatus for determining the location of an object by the use of radio-waves. The most visible and ubiquitous aspects of radar are the rotating, curved-surface antennas seen on the top of most ships and airport towers. Not visible, but equally important, are the radar antennas hidden in the noses of aeroplanes.

It is a system employing microwaves for the purpose of locating, identifying, navigating or guiding such objects as ships, aircrafts, missiles or official satellites. It can determine the direction, distance, height and speed of objects that are not visible to the human eyes.

The working principle of radar is similar to that of sight. We see an object when light waves fall on an object and are reflected from it, and reach our eyes forming an image of it. Radar uses a powerful radio transmitter to illuminate objects with radio-waves and a sensitive radio receiver to detect the reflected waves, also called echoes, which are amplified and electronically transformed so that they can be seen on a display monitor as spots of light or as an image of the object observed. A single antenna, generally, serves both as a transmitter and receiver.

In operation, radar antennas emit pulses of radio-waves, about 1000 pulses per second, each lasting about a millionth of a second. The waves travel at the speed of light, i.e., 3,00,000 kms per second or 1,86,000 miles per second, until they strike some reflecting surface, which may be almost anything from solid rock to the water vapour in clouds. The reflected waves are received by the same antenna, in the intervals between the pulses. The time interval between outgoing and reflected pulses is continually translated into visual data on the screen of a cathode ray tube, similar to a TV picture tube. The time taken for the reflected waves to return, gives the distance of the object and the direction of return tells about its location.

Application: Radar has a large variety of applications, involving precise measurements of distances. Besides, being used for navigating ships and aircrafts, it is used for mapping storms and other meteorological disturbances, and studying planets and their Moons or Satellites.

It is used for determining altitudes of aeroplanes, navigating in fog and in the dark, and even mapping the cloud-shrouded surface of Venus. A useful application of radar is for 'police speed traps'. Here, a special radar device is used, which responds differently to the reflections from moving objects and stationary objects.

SONAR:

Acronym for Sound Navigation and Ranging, Sonar is a technique and apparatus for determining the location of an object by reflected sound-waves. In fact, it is a system for detecting and locating submerged objects or communication under water by transmitting a high frequency sound wave and collecting the reflected wave.

The Sonar principle is used to determine the depth of shallow bodies of water and to locate fish, under-water submarines, mines, wrecks, and other obstacles. Initially, developed as a military instrument for locating submarines, it is widely used for measuring water depth, and in Arctic regions, for measuring ice-thickness.

In Active Sonar, pulses of high-frequency (high-pitched) sounds are beamed downwards and at angles from the bottom of a ship. The 'echoes' are received by an apparatus that

measures the time interval, then computes the distance and friction of the reflecting object. This information is shown on a dial or plotted automatically on a chart. Passive Sonar does not send out sounds. It detects sounds made by submarine engines or other sound-producing objects.

MISCELLANEOUS

Scientific Institutions

Institutes	Location
Agharkar Research Institute	Pune
Bose Institute	Kolkata
Jawaharlal Nehru Centre for Advanced Scientific Research	Bengaluru
Indian Association for the Cultivation of Sciences	Kolkata
Indian Institute of Astrophysics	Bengaluru
Shri Chaitra Tirunal Institute for Medical Sciences and Technology	Thiruvananthapuram
S.N. Bose National Centre for Basic Sciences	Kolkata
Raman Research Institute	Bengaluru
Birbal Shahni Institute of Palaeobotany	Lucknow
Indian Institute of Geomagnetism	Mumbai
International Advanced Research Centre for Power Metallurgy and New Materials	Hyderabad
Wadia Institute of Himalayan Geology	Dehradun
Indian Academy of Sciences	Bengaluru
Indian National Science Academy	New Delhi
Indian National Academy of Engineering	New Delhi
Indian Science Congress Association	Kolkata
National Academy of Sciences	Allahabad
Bhabha Atomic Research Centre (BARC)	Mumbai
Indira Gandhi Centre for Atomic Research (IGCAR)	Kalpakkam
Centre for Advanced Technology (CAT)	Indore
Variable Energy Cyclotron Centre (VECC)	Kolkata
Atomic Minerals Directorate for Exploration and Research (AMD)	Hyderabad
Heavy Water Board (HWB)	Mumbai
Nuclear Fuel Complex (NFC)	Hyderabad
Board of Radiation and Isotope Technology (BRIT)	Mumbai
Nuclear Power Corporation of India Ltd. (NPCIL)	Mumbai

Uranium Corporation of India Ltd. (UCIL)	Jharkhand (Jaduguda)
Indian Rare Earth Ltd. (IRE)	Mumbai
Electronic Corporation of India Ltd. (ECIL)	Hyderabad
Tata Institute of Fundamental Research (TIFR)	Mumbai
Tata Memorial Centre (TMC)	Mumbai
Saha Institute of Nuclear Physics (SINP)	Kolkata
Institute of Physics (IOP)	Bhubaneshwar
Harish Chandra Research Institute (HRI)	Allahabad
Institute of Mathematical Sciences (IMSC)	Chennai
The Institute for Plasma Research (IPR)	Ahmedabad
National Natural Resources Management System (NNRMS)	Bengaluru
Vikram Sarabhai Space Centre (VSSC)	Thiruvananthapuram
ISRO Satellite Center	Bengaluru
Sriharikota High Altitude Rocket (SHAR) Centre	Sriharikota
Space Application Centre (SAC)	Ahmedabad
Liquid Propulsions System Center (LPSC)	Bengaluru, Valiamala (Kerala) & Mahendragiri (T.N)
Development and Educational Communication Unit (DECU)	Ahmedabad
National Remote Sensing Agency (NRSA)	Hyderabad
Physical Research Laboratory (PRL)	Ahmedabad
ISRO Inertial System Unit	Thiruvananthpuram
ISRO Telemetry Tracking and Command Network (ISTRAC)	Bengaluru
National Institute of Immunology (NII)	New Delhi
National Facilities For Animal Tissue and Cell Culture (NFATCC)	Pune
National Facility for Plant Tissue Culture Repository (NFPTCR)	New Delhi
Central Institute of Medicinal and Aromatic Plants (CIMAP)	Lucknow
National Bureau of Plant Genetic Resource (NBPGR)	New Delhi
Tropical Botanical Garden and Research Institute (TBGRI)	Trivandrum
National Dairy Research Institute (NDRI)	Karnal, Haryana

COMPUTER TERMINOLOGY

- **Access:** To retrieve data from a storage device such as a hard disk, or to log in to a computer system or network.
- **Algorithm:** A formal set of instructions that can be followed to perform a specific task, such as a mathematical formula or a set of instructions in a computer program.
- **Aliasing:** In computer graphics, the effect produced by diagonal lines, curves or circles, when display resolution is too coarse to hide the stair-stepped jagged appearance. Aliasing is also seen when a bit-mapped graphic is enlarged many times its original size.
- **Animation:** A method of creating the illusion of movement by displaying a series of slightly different images very quickly so that the eye is deceived into seeing smooth motion. Animation is a major component of multimedia applications and is widely used in computer games.
- **Attenuation:** In communications, the decrease in power of a signal transmitted over a wire. Attenuation is measured in decibels, and increases as the power of the signal decreases.
- **Bounce:** The return of an e-mail message to its original sender due to an error in delivery. This may be due to a simple spelling mistake in the e-mail address, the recipient's computer system may be down, or they may no longer subscribe to or have an account on the system.
- **Brouter:** In networking, a device that combines the attributes of a bridge and a router. A brouter can route one or more specific protocols, such as TCP/IP, and bridge all others.
- **Browser:** An application program used to explore Internet resources. A browser lets you wander from node to node without concern for the technical details of the links between the nodes or the specific methods used to access them, and presents the information-text, graphics, sound, or video-as a document on the screen.
- **Compatibility:** The extent to which a given piece of hardware or software conforms to an accepted standard regardless of the original manufacturer.
- **Compiler:** A program that translates a high-level programming language such as C or Pascal into a machine language program.
- **Connectivity:** In networking, the degree to which any given computer or application program can cooperate with other network components, either hardware or software, purchased from other vendors.
- **Cropping:** An editing operation during which pieces of a graphics image or a halftone are removed to make the image fit into a given area, or to remove unnecessary parts of the image.
- **Cyberspace:** A descriptive term for the virtual geography of the online world. This term first appeared in print in William Gibson's novel Neuromancer, published in 1984, where it describes the online world of computers and the elements of society that use these computers.
- **Debugging:** The process of finding, locating and removing logical or syntactical errors from a computer program.
- **Defragmentation:** The process of reorganizing and rewriting files so that they occupy one large continuous area on your hard disk rather than several smaller areas.
- **Digitizer:** A computer peripheral that converts linear pictorial information such as maps into digital data by tracing the image with a puck. Also known as a digitizing tablet.
- **Dithering:** In computer graphics, the use of dots of different colours or shades to produce what seems to be a new colour.
- **Documentation:** The instructions, tutorials, specifications, troubleshooting advice, and reference guides that

accompany a computer program or a piece of hardware.

- **e-mail:** Also called electronic mail. The use of a network to transmit text messages, memos, and reports.
- **Emulator:** A device built to work exactly like another device, either hardware, software or a combination of both.
- **Encapsulation:** The primary goal of encapsulation is to isolate the internal workings of a particular object class, so that it can be changed and improved by the programmer without causing dangerous side effects anywhere else in the system. By using encapsulation, large programs can be made much more readable, because all of the data and related code is in the same place.
- **Encryption:** The process of encoding information in an attempt to make it secure from unauthorized access. The reverse of this process is known as decryption.
- **Ethernet:** A popular network protocol and cabling scheme with a transfer rate of 10 megabits per second, originally developed by Xerox in 1976.
- **Firewall:** A method of preventing unauthorized access to a computer system, often found on networked computers. A firewall is designed to provide normal service to authorized users, while at the same time preventing those unauthorized users from gaining access to the system.
- **Freeware:** A form of software distribution where the author retains copyright of the software, but makes the program available to others at no cost. Freeware is often distributed on bulletin boards, or through user groups. The program may not be resold or distributed by others for profit.
- **Genlocking:** A contraction of generator lock. The synchronization and superimposition of computer generated text or graphics onto a video signal, so that the two images can be combined onto the same signal and displayed at the same time.
- **Handshaking:** The exchange of control codes or particular characters to maintain and coordinate data flow between two devices, so that data is only transmitted when the receiving device is ready to accept the data.
- **Hypertext:** A method of presenting information so that it can be viewed by the user in a non-sequential way, regardless of how the topics were originally organized.
- **Interface:** That point where a connection is made between two different parts of a system, such as between two hardware devices, between a user and program or operating system, or between two application programs.
- **Interoperability:** The ability to run application programs across local, wide, and metropolitan area networks, giving users convenient access to data and application programs across multi-vendor networks.
- **Lurking:** The practice of reading an Internet mailing list or USENET newsgroup without posting anything yourself.
- **Mail Merge:** A facility found in most word processors that joins two files together to produce a mass mailing of personalized form letters.
- **Mnemonic:** Pronounced 'nem-onic'. A name or abbreviation used to help you remember a long or complex instruction. Programming languages use many different mnemonics to represent complex instructions.
- **Morphing:** A contraction of meta-morphosing. The use of specialized animation software to change one image into another using a series of intermediate images. Morphing is used to provide many of the special effects seen in popular movies where a man turns into a wolf, or a fluffy kitten changes into a furious roaring lion.
- **Multithreading:** The concurrent processing of several tasks or threads inside the same program. Because several

tasks can be processed in parallel, one task does not have to wait for another to finish before starting.

- **Outsourcing:** To subcontract a company's data processing operations to outside contractors rather than maintain corporate hardware, software, and staff. Out sourcing is often used as a cost-cutting mechanism, although the cost savings are sometimes difficult to quantify.
- **Portability:** The degree to which a program can be moved easily to various different computing environments with a minimum number of changes.
- **Posting:** The process of sending an individual article or e-mail message to a USENET newsgroup or to a mailing list.
- **Prodigy:** An online information service providing a variety of services to users of personal computers, including sports, weather and stock market reports, travel information, and home shopping services.
- **Programming:** The process of designing, writing, testing, debugging, documenting, and maintaining a program.
- **Protocol:** In networking and communications, the specification that defines the procedures to follow when transmitting and receiving data. Protocols define the format, timing, sequence, and error checking systems used.
- **Router:** In networking, an intelligent connecting device that can send packets to the correct local area network segment to take them to their destination.
- **Semaphore:** In programming, an interprocess communication signal that indicates the status of a shared system resource, such as shared memory.
- **Sort:** To place a set of data items into an ordered list, either numerically, alphabetically, or by some other criteria like file date or time.
- **Spamming:** To flood someone's mailbox with unwanted e-mail messages.
- **Swapping:** The process of exchanging one item for another. In a virtual memory system, swapping occurs when a program requests a virtual memory location that is not currently in memory; the information is then read from disk, and displaces old information held in memory.
- **Telecommuting:** Working at home on a computer connected to the office by modems and telephone lines instead of commuting to the office.
- **Teleconferencing:** The use of audio, video, or computer systems, linked by a communications channel, to allow widely separated individuals to take part in a discussion or meeting all at the same time.
- **Thesaurus:** In word processing, a program feature that locates and suggests alternative words, or synonyms, from a list of alternative words stored on disk.
- **Thrashing:** An excessive amount of disk activity in a virtual memory system, to the point where the system is spending all its time swapping pages in and out of memory, and no time executing the application.
- **Topology:** The map of a network. Physical topology describes where the cables are run and the workstations or nodes are located: logical topology refers to the paths that messages take to get from one user on the network to another.
- **Trojan horse:** A type of virus that pretends to be a useful program, such as a game or a utility program, when in reality it contains special code that will internationally damage any system onto which it is loaded.
- **Virtual memory:** A memory-management technique that allows information in physical memory to be swapped out to a hard disk. This technique provides application programs with more memory space than is actually available in the computer.
- **Virtual reality:** Abbreviated VR. A computer generated environment that presents the illusion of reality. The user may wear a head-mounted display (HMD) which displays a three-dimensional image of the environment, and use an instrumented glove to manipulate objects within the environment.

- **Voice mail:** A computerized store-and-forward system for voice messages. A voice mail system uses prerecorded messages to route the caller to the correct person, department, or mailbox, and then digitizes the incoming messages and stores them on disk. Recipients can review their messages and can often forward them to another department or person after attaching their own comments.
- **Wizard:** A technique used by some applications to guide the inexperienced or infrequent user through a complex set of steps by asking questions about the document they are in the process of creating as they are actually creating it.
- **Channel:** In an ISDN system it is the bearer channel that carries voice or data at 64 kbps in either direction. This is in contrast to D channel which is used for control signals and data about the call several B channels can be multiplexed into higher rate H channel.
- **HiperLAN:** HiperLAN is a set of wiereless local area network (WLAN) communication standard primarily used in European countries. There are two specifications. HiperLAN/I and HiperLAN/2. Both have been adopted by the European Telecommunications Standards Institute. The HiperLAN standards provide features and capability similar to those of the IEEE 802.11 WLAN standard used in US and other countries.
- **Finger:** An Internet tool for locating people on other sites. Finger can also be used to give access to non-personal information, but the most common use is to see if a person has an account at a particular site.
- **Phishing:** A technique whereby the websites of known institutions are entirely or partly copied and e-mails are used to obtain private or confidential data of the customers of those institutions. The request to provide those data is often motivated by so-called safety measures or the need to update data banks.
- **Plug-in:** A small piece of software that adds features to a larger software application. Common plug-ins are those for web browsers (Real Audio, Quick Time, etc.) or graphics programs (Kai's Power Tools, DigiMarc, etc.)
- **Shell Account:** A software application that allows use of another machine's Internet connection. Users do not have a direct Internet connection, instead, an Internet connection is made through a host computer's connection.
- **Packet filter:** Looks at each packet entering or leaving the network and accepts or rejects it based on user-defined rules. Packet filtering is fairly effective and transparent to users, but it is difficult to configure. In addition, it is susceptible to IP spoofing.
- **Application Gateway:** Applies security mechanisms to specific applications, such as FTP and Telnet servers. This is very effective, but can impose a performance degradation.
- **Proxy Server:** Intercepts all messages entering and leaving the network. The proxy server effectively hides the true network addresses. In practice, many firewalls use two or more of these techniques in concert. A firewall is considered a first line of defence in protecting private information. For greater security, data can be encrypted.
- **Flame War:** When an online discussion degenerates into a series of personal attacks against the debaters, rather than a discussion of their positions, it is referred to as a flame war.
- **Information Superhighway:** There is some debate about this term. Some claim it refers to the future, where everyone will have fast, easy access to the Internet and things such as video conferencing will be widely available. Others claim that the Internet as we already know it is the information Superhighway.
- **Masking:** To conceal a web site's URL in some manner, normally by using a domain name. For example, if a URL shows up as "http://www.example.com/" but the web site is actually located at

"http://www.somewhere-else.com/example/", that URL is said to be "masked".

- **Ping:** A program for determining if another computer is presently connected to the Internet.
- **Trolling:** The act of deliberately posting false or inflammatory information in order to start a flame war or cause aggravation to others.
- **Pixel:** Shorthand for "picture element", a pixel is the smallest unit of resolution on a monitor. It is commonly used as a unit of measurement.
- **Router:** A computer or software package that handles the connection between two or more networks. Routers spend all their time looking at the destination addresses of the packets passing though them to decide which route to send them on.
- **Bookmark:** It's just an address book entry for a Web Address. Some browsers call this a Favourite Place or a Hot Spot. Most browsers contain a simple "address book" where the reader can store the addresses of their favourite places. Click on the name of the place, and the Browser automatically goes there, like an online phone book with an autodialer. Bookmaking a site just means adding it to your address book. When someone bookmarks your site, it means they are probably going to come back.
- **Data Compression:** Any method of encoding data so that it occupies less space than in its original form. Many different mathematical techniques can be used, but the overall purpose is to compress the data so that it can be stored, retrieved, or transmitted more efficiently. Data compression is used in facsimile and many other forms of data transmission, CD-ROM publishing, still image and video image manipulation and database management systems.

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GREAT INDIAN SCIENTISTS

CHRONICLE IAS ACADEMY
A CIVIL SERVICES CHRONICLE INITIATIVE

ARYABHATTA

Aryabhatta was a great mathematician and astronomer of India and the earliest known author on Algebra. It is believed that he was born in 476 A.D. in Kusumpur, India. Aryabhatta was a fifth century mathematician, astronomer, astrologer and physicist. He was a pioneer in the field of mathematics. At the age of 23, he wrote Aryabhattiya, which is a summary of mathematics of his time.

There are four sections in this scholarly work. In the first section he describes the method of denoting big decimal numbers by alphabets. In the second section, we find difficult questions from topics of modern day Mathematics such as number theory, geometry, trigonometry and Beejganita (algebra). The remaining two sections are on astronomy.

Achievements & Contribution

Mathematics:

Aryabhatta's contribution in mathematics is unparalleled. He suggested formula to calculate the areas of a triangle and a circle, which were correct. He was the first mathematician to give the 'table of the sines', which is in the form of a single rhyming stanza. This remarkable man was a genius and continues to baffle many mathematicians of today. His works was then later adopted by the Greeks and then the Arabs.

Pi as Irrational: Aryabhata worked on the approximation for Pi (π), and may have realized that π is irrational. In the second part of the Aryabhatiya, he writes "Add four to 100, multiply by eight and then add 62,000. By this rule the circumference of a circle of diameter 20,000 can be approached." In other words, $\pi = \sim 62832/20000 = 3.1416$, correct to five digits. After Aryabhatiya was translated into Arabic (ca. 820 AD) this approximation was mentioned in Al-Khwarizmi's book on algebra.

Discovery of zero: Aryabhatta showed that zero was not a numeral only but also a symbol and a concept. Discovery of zero enabled Aryabhatta to find out the exact distance between the earth and the moon. The discovery of zero also opened up a new dimension of negative numerals.

Algebra: His other works include algebra, arithmetic, trigonometry, quadratic equations and the sine table. He gave the formula $(a + b)^2 = a^2 + b^2 + 2ab$

Astronomy:

The last two sections of Aryabhattiya were on Astronomy. Evidently, Aryabhatta contributed greatly to the field of science too, particularly Astronomy.

In ancient India, the science of astronomy was well advanced. It was called Khagolshastra. Khagol was the famous astronomical observatory at Nalanda, where Aryabhatta studied. In fact science of astronomy was highly advanced and our ancestors were proud of it.

The aim behind the development of the science of astronomy was the need to have accurate calendars, a better understanding of climate and rainfall patterns for timely sowing and choice of crops, fixing the dates of seasons and festivals, navigation, calculation of time and casting of horoscopes for use in astrology. Knowledge of astronomy, particularly knowledge of the tides and the stars, was of great importance in trade, because of the requirement of crossing the oceans and deserts during night time.

Disregarding the popular view that our planet earth is 'Achala' (immovable), Aryabhatta stated his theory that 'earth is round and rotates on its own axis' He explained that the appearance of the sun moving from east to west is false by giving examples. One such example was: When a person travels in a boat, the trees on the shore appear to move in the opposite direction. He also correctly stated that

the moon and the planets shined by reflected sunlight.

He was the first person to say that Earth is spherical and it revolves around the sun. He already knew that the earth spins on its axis, the earth moves round the sun and the moon rotates round the earth. He talks about the position of the planets in relation to its movement around the sun. He refers to the light of the planets and the moon as reflection from the sun. He also gave a scientific explanation for solar and lunar eclipse. He goes as far as to explain the eclipse of the moon and the sun, day and night, the contours of the earth, the length of the year exactly as 365 days.

He even computed the circumference of the earth as 24835 miles which is close to modern day calculation of 24900 miles.

Sidereal periods: Considered in modern English units of time, Aryabhata calculated the sidereal rotation (the rotation of the earth referenced the fixed stars) as 23 hours 56 minutes and 4.1 seconds; the modern value is 23:56:4.091. Similarly, his value for the length of the sidereal year at 365 days 6 hours 12 minutes 30 seconds is an error of 3 minutes 20 seconds over the length of a year. The notion of sidereal time was known in most other astronomical systems of the time, but this computation was likely the most accurate in the period.

Recognition and Honours

India's first satellite Aryabhata, was named after him and the lunar crater Aryabhata is named in his honour.

SATYENDRA NATH BOSE

Satyendra Nath Bose was the great physicist of the universe, born on January 1, 1894, in Calcutta (now Kolkata). Satyendra Nath Bose discovered what became known as ‘bosons’ and went on to work with Albert Einstein to define one of two basic classes of subatomic particles. Much of the credit for discovering the boson, or "God particle," was given to British physicist Peter Higgs, much to the chagrin of the Indian government and people.

His father Surendranath was employed in the Engineering Department of the East India Railway. As a student of the Hindu High School, Bose once was awarded 110 marks out of 100 in mathematics because he had solved some problems in the exam paper by more than one method. He made a name for himself in school due to his love for science; in collaboration with some of his friends, he constructed a telescope and other scientific instruments. “

Achievements & Contribution

Scientists at Europe's CERN research centre have found a new subatomic particle that could be the Higgs boson, the basic building block of the universe. It is well known that the 'Higgs' of Higgs boson refers to British physicist Peter Higgs, who in 1964 laid much of the conceptual groundwork for the presence of the elusive particle. However, it's not exactly common knowledge that the term "boson" owes its name to the pioneering work of the late Indian physicist, Satyendra Nath Bose.““Bose completed his graduation from Presidency College in Kolkata and Masters from Calcutta University. He joined the Physics Department of Calcutta University in 1916. After completing his master's degree, Bose became a research scholar at the University of Calcutta in 1916 and began his studies on the theory of relativity. In 1921, Bose joined the physics department at the University of Dhaka, which had then been recently formed, and went on to establish new departments, laboratories and libraries in which he could teach advanced courses.

Bose, who worked in Kolkata and Dhaka, was a contemporary of Albert Einstein. He made important contributions to the field of quantum physics in the 1920s that changed how particle physics has been studied ever since.

Bose wrote a paper in 1924 in which he derived Planck's quantum radiation law without referencing classical physics—which he was able to do by counting states with identical properties. The paper would later prove seminal in creating the field of quantum statistics.

In 1924, Bose sent the paper to Albert Einstein in Germany, and the scientist recognized its importance, translated it into German and submitted it on Bose's behalf to the prestigious scientific journal Zeitschrift für Physik. The publication led to recognition, and Bose was granted a leave of absence to work in Europe for two years at X-ray and crystallography

laboratories, where he worked alongside Einstein and Marie Curie, among others.

Einstein had adopted Bose's idea and extended it to atoms, which led to the prediction of the existence of phenomena that became known as the Bose-Einstein Condensate, a dense collection of bosons—particles with integer spin that were named for Bose.

After his stay in Europe, Bose returned to the University of Dhaka in 1926. Although he did not have a doctorate, Einstein had recommended he be made a professor, and so Bose was made head of the physics department. But upon his return, Bose did not publish for a significant period of time.

According to a July 2012 New York Times article in which Bose is described as the "Father of the 'God Particle,'" the scientist's interests wandered into other fields, including philosophy, literature and the Indian independence movement. He published another physics paper in 1937 and in the early 1950s worked on unified field theories.

After 25 years in Dhaka, Bose moved back to Calcutta in 1945 and continued to research and teach there until his death in 1974.

Recognition and Honours

The Government of India honored Bose in 1954 with the prestigious Padma Vibhushan, the second-highest civilian award in India. Five years later, he was appointed as the National Professor, the highest honor in the country for a scholar. Bose remained in that position for 15 years. Bose also became an adviser to the Council of Scientific and Industrial Research, as well as president of the Indian Physical Society and the National Institute of Science. He was elected general president of the Indian Science Congress and president of the Indian Statistical Institute. In 1958, he became a Fellow of the Royal Society.

About 12 years after Bose's death on February 4, 1974, the Indian parliament established the S.N. Bose National Centre for Basic Sciences in Salt Lake, Kolkata.

PRAFULLA CHANDRA RAY

"Prafulla Chandra Ray was an eminent scientist, an exemplary entrepreneur, a patriot and a passionate teacher. Prafulla Chandra Ray was the founder of the Indian School of modern chemistry. He was a pioneer of chemical industries in India. Ray's activities were not confined to his laboratory and teaching. His activities concerned with all spheres of human interest—educational reform, industrial development, employment generation & poverty alleviation, economic freedom and political advancement of the country. He was a pioneer in social reform in the country. He took to social service with a missionary zeal. He was a great critique of the prevailing caste system in the Hindu society.

P C Ray was born on 2 August 1861 in Raruli-Katipara, a village in the District of Khulna (in present day Bangladesh). His early education started in his village school. After attending the village school, he went to Kolkata, where he studied at Hare School and the Metropolitan College. The lectures of Alexander Pedler in the Presidency College, which he used to attend, attracted him to chemistry, although his first love was literature. He continued to take interest in literature, and taught himself Latin and French at home. After obtaining a F.A. diploma from the University of Calcutta (now Kolkata), he proceeded to the University of Edinburgh on a Gilchrist scholarship where he obtained both his B.Sc. and D.Sc. degrees.

Achievements & Contribution

Prafulla Chandra Ray, one of the first Indian chemical researchers, studied at the prestigious Edinburgh University. After graduating from university, he took a position as a Chemistry Professor at the Presidency College in 1889. Berthelot who was a very famous chemist, helped and encouraged him with his admirable research in Ayurveda.

In 1888, P C Ray made his journey home to India. Initially he spent a year working with his famous friend Jagadish Chandra Bose in his laboratory. In 1889, Prafulla Chandra was appointed an Assistant Professor of Chemistry in the Presidency College, Kolkata. His publications on mercurous nitrite and its derivatives brought him recognition from all over the world. Equally important was his role as a teacher - he inspired a generation of young chemists in India thereby building up an Indian

school of chemistry. Famous Indian scientists like Meghnad Saha and Shanti Swarup Bhatnagar were among his students.

In 1902, his research work of History of Hindu Chemistry was published. P C Ray believed that the progress of India could be achieved only by industrialization. He set up the first chemical factory in India, with very minimal resources, working from his home. In 1901, this pioneering effort resulted in the formation of the Bengal Chemical and Pharmaceutical Works Ltd.

He retired from the Presidency College in 1916, and was appointed as Professor of Chemistry at the University Science College. In 1921 when P C Ray reached 60 years, he donated, in advance, all his salary for the rest of his service in the University to the development of the Department of Chemistry and to the creation of two research fellowships. The value of this endowment was about two lakh rupees. He eventually retired at the age of 75. In 1936 Ray retired from his service in the University College of Science but he continued as Emeritus Professor of Chemistry till his death. He got elected as the Indian Science Congress President in 1920.

In P C Ray, the qualities of both a scientist and an industrial entrepreneur were combined and he can be thought of as the father of the Indian Pharmaceutical industry. P C Ray died on June 16, 1944 in his living room in the University College of Science of the Calcutta University.

PROF. PRASANTA CHANDRA MAHALANOBIS

Prasanta Chandra Mahalanobis was a great scientist and applied statistician. He is famous for the 'Mahalanobis Distance', a statistical measure. He did pioneering work on anthropometric variation in India. Professor Mahalanobis made valuable contributions to the development of statistical science in India.

Scientist P.C. Mahalanobis was born on June 29, 1893 and died on June 28, 1972. He was the son of Prabodh Chandra and Nirodbasini. His father was an active member of the Sadharan Brahmo Samaj. He started education from Brahmo Boys School in Calcutta (now Kolkata). Then he completed graduation in physics from the Presidency College, Calcutta in 1912. He also completed Tripos at King's College, Cambridge. After that he came back to Calcutta, India, and here he was introduced to the Principal of Presidency College and was invited to take classes in physics.

Achievements & Contribution

Prof. Mahalanobis's first paper on statistics entitled 'Anthropological Observations on Anglo-Indians of Calcutta, Part I: Male Stature', published in Records of the Indian Museum in 1922. This paper attracted the attention of Sir Gilbert Walker, Director General of Observatories, who requested Mahalanobis to undertake a systematic study of some metrological problems. This resulted in an important discovery by Mahalanobis that the region of highest control for changes in weather on the surface of the earth is located about 4 kilometers above sea-level. Subsequently, he was appointed Meteorologist in the Alipore Observatory and he held this post from 1922 to 1926.

At the request of the Indian Government, Mahalanobis undertook some work on prevention of floods in various regions of the country. His findings and recommendations, though often contrary to engineering wisdom of the time, were accepted by the Government and resulted in alleviation of the problem of flooding to a large extent.

Lasting Gift to Statistics:

Mahalanobis's contributions to large scale sample surveys are among his most significant and lasting gifts to statistics. He stared his work on sample surveys with estimation of area and yield of jute crop in Bengal in 1937.

He made many methodological contributions to survey sampling that included optimal choice of sampling design using variance and cost functions, and the technique of interpenetrating network of subsamples for assessment and control of errors, especially non-sampling errors, in surveys. The concept of pilot surveys was a forerunner of sequential sampling developed by Abraham Wald, as acknowledged by Wald in his book. In addition to introducing these concepts, Mahalanobis raised important and

difficult philosophical questions on randomness and representativeness of a sample, which remain relevant and challenging even today.

He was elected Chairman of the United Nations Subcommission on Statistical Sampling in 1947, and held the post till 1951. His tireless advocation of the usefulness of sample surveys resulted in the final recommendation of this subcommission that sampling methods should be extended to all parts of the world. Mahalanobis received the Weldon Medal from Oxford University in 1944 and was elected a Fellow of the Royal Society, London, in 1945, for his fundamental contributions to Statistics, particularly in the area of large-scale sample surveys.

Plans for Economic Prosperity of Nation:

Mahalanobis believed that statistics should be an integral part of the dynamics of national planning. He was acutely aware of national problems and national resources. He took a keen interest and played a key role in formulating India's second five-year plan based on the four-sector model developed by him. Broad sectoral allocations of employment, capital investment and increment in national income were worked out and then split into detailed targets. Even though national planning seems to have now gone out of fashion, the need for planning in the initial stages of a nation's development is still acknowledged and Mahalanobis's contributions to Indian national planning continue to be held in high esteem by economists.

During the last decade of his life, he devised a statistical method, fractile graphical analysis, for comparison of socio-economic conditions of groups of people. This technique has now been used in many other branches of science.

ISI as an Institution of National Importance:

The year 1931 marks a watershed in the development of statistics in India. From the fledgling Statistical Laboratory formed in the early 1920s by Mahalanobis within the Physics department of Presidency College, he founded the Indian Statistical Institute on 17 December, 1931. In 1959, by an act of the Indian Parliament, the Institute was declared as an 'Institution of National Importance'.

Statistical System in India:

Mahalanobis's role as a planner prompted him to play a pioneering role in the organized collection of official statistics. He established the National Sample Survey in 1950 with the objective of providing comprehensive statistics relating to all economic and social aspects on an all-India basis. He also helped in setting up of the Central Statistical Organization in India, an apex body for coordination of statistical activities in India. He was instrumental in the establishment of formal teaching of statistics in many Indian universities and also in the Indian Statistical Institute. In collaboration with the International Statistical Institute, he established an International Statistical Education Centre at the Indian Statistical Institute.

Recognition and Honours

Mahalanobis became the Honorary President of the International Statistical Institute in 1957, and was elected a fellow of the American Statistical Association in 1961. Throughout his career he received many other academic honours and awards. He received the highest national honour, Padma Vibhushan, from the President of India in 1968 for his contribution to science and services to the country.

He had appointed as the Honorary Statistical Advisor to the cabinet of the Government of India. He had Weldon medal from Oxford University in 1944. He was also elected a fellow of the Royal Society, London in 1945.

SIR C. V. RAMAN

Chandrasekhara Venkata Raman was a great Physicist of India born on November 7th, 1888, in a small village of Thiruvanaikaval near Tiruchirapalli (Trichonopoly in those days), Tamil Nadu. His father was a lecturer in mathematics and physics so that from the first he was immersed in an academic atmosphere. He entered Presidency College, Madras (now Chennai), in 1902, and in 1904 passed his B.A. examination, winning the first place and the gold medal in physics; in 1907 he gained his M.A. degree, obtaining the highest distinctions."

Contributions and Achievements:

C. V. Raman earliest researches in optics and acoustics - the two fields of investigation to which

he has dedicated his entire career - were carried out while he was a student. Since at that time a scientific career did not appear to present the best possibilities, Raman joined the Indian Finance Department in 1907; though the duties of his office took most of his time, Raman found opportunities for carrying on experimental research in the laboratory of the Indian Association for the Cultivation of Science at Calcutta (now Kolkata).

In 1917 he was offered the newly endowed Palit Chair of Physics at Calcutta University, and decided to accept it. After 15 years at Calcutta he became Professor at the Indian Institute of Science at Bangalore (1933-1948), and since 1948 he is Director of the Raman Institute of Research at Bangalore, established and endowed by himself. He also founded the Indian Journal of Physics in 1926, of which he is the Editor. Raman sponsored the establishment of the Indian Academy of Sciences and has served as President since its inception. He also initiated the Proceedings of that academy, in which much of his work has been published, and is President of the Current Science Association, Bangalore, which publishes *Current Science (India).*

Raman made many major scientific discoveries in acoustics, ultrasonic, optics, magnetism and crystal physics. Raman's works on the musical drums of India was epoch-making and it revealed the acoustical knowledge of the ancient Hindus. It may be noted here that it was Pythagoras who first formulated what makes a sound musical to the human ear.

Some of Raman's early memoirs appeared as Bulletins of the *Indian Association for the Cultivation of Science* (Bull. 6 and 11, dealing with the "Maintenance of Vibrations"; Bull. 15, 1918, dealing with the theory of the musical instruments of the violin family). He contributed an article on the theory of musical instruments to the 8th Volume of the Handbuch der Physik, 1928.

In 1922 he published his work on the "Molecular Diffraction of Light", the first of a series of investigations with his collaborators which ultimately led to his discovery, on the 28th of February, 1928, of the radiation effect which bears his name and which gained him the 1930 Nobel Prize in Physics.“Other investigations carried out by Raman were: his experimental and theoretical studies on the diffraction of light by acoustic waves of ultrasonic and hypersonic frequencies (published 1934-1942), and those on the effects produced by X-rays on infrared vibrations in crystals exposed to ordinary light.

In 1948 Raman, through studying the spectroscopic behaviour of crystals, approached in a new manner fundamental problems of crystal dynamics. His laboratory has been dealing with the structure and properties of diamond, the structure and optical behaviour of numerous iridescent substances (labradorite, pearly felspar, agate, opal, and pearls).

Raman developed a vibrant and excellent school of physics. He established the Indian Academy of Sciences Bangalore (1934) and the Raman Research Institute (1948). Among his other interests have been the optics of colloids, electrical and magnetic anisotropy, and the physiology of human vision. Sir C.V. Raman died on November 21, 1970.

Recognition and Honours

Raman was honoured with a large number of honorary doctorates and memberships of scientific societies. Raman was elected as a Fellow of the Royal Society of London in 1924 in recognition of his outstanding researches in physical optics, molecular diffraction of light, X-ray scattering by liquids and a molecular anisotropy. It may be noted that Raman had resigned the Fellowship of the Royal Society. He was conferred a Knighthood by the British Government in 1929. In 1941 he was awarded the Franklin Medal. The erstwhile Soviet Union honoured him with the International Lenin Prize in 1957.

In 1930, C. V. Raman was the first `non-white', Asian and Indian to receive the Nobel prize in physics for his work on scattering of light and discovery of the Raman effect. In 1954 the Government of India awarded him the title of the Bharat Ratna. India celebrates National Science Day on 28 February of every year to commemorate the discovery of the Raman Effect in 1928.

JAGADISH CHANDRA BOSE

Jagadish Chandra Bose was an Indian scientist who discovered and proved in the world

that plants also have life. They consume food and sleep during nights, and wake up early in the mornings. Pain and pleasures are there for plants too. They also have birth, growth and death, as human beings. He is regarded as India's first modern scientist. Jagadis Chandra Bose was born on 30th November 1858 in Mymensingh, now in Bangladesh.

He had his early education in St. Xavier's High School, and college education in Calcutta (now Kolkata) and later at Cambridge, England. He joined the Presidency College, Calcutta as Assistant Professor of Physics in 1855.

Contributions and Achievements:

J. C. Bose is one of the most prominent first Indian scientists who proved by experimentation that both animals and plants share much in common. Bose demonstrated that plant tissues under different kinds of stimuli like mechanical, application of heat, cold, light, noise, electric shock, chemicals and drugs, produce electric response similar to that produced by animal tissues. He also tried to demonstrate that similar electric response to stimulation could be noticed in certain inorganic systems. For his investigations Bose invented several novel and highly sensitive instruments. Among these the most important one was the Crescograph -an instrument for measuring the growth of a plant. It could record a growth as small as 1/100,000 inch per second.

Bose's experiments on plants were mostly performed on Minosa pudica and Desmondium gyrans (Indian Telegraph plant). His findings subsequently influenced subjects like physiology, chronobiology, cybernetics, medicine and agriculture.

Bose did pioneering research, first in physics and then in physiology. In 1888 Heinrich Rudolf Hertz (1857-94) produced and detected electromagnetic waves in the 60 cm wavelength range and in doing so he verified James Clerk Maxwell's (1831-79) electromagnetic theory. However, Bose was the first to produce millimeter-length radio waves and study their properties. Bose was a pioneer in microwave optics technology. He was the first to show that semiconductor rectifiers could detect radio waves. Bose's galena receiver was amongst the earliest examples of a lead sulphide photo conducting device.

Bose devised and fabricated a new type of radiator for generating radio waves. He also built a unique and highly sensitive 'Coherer' or radio receiver for detecting radio waves. Bose's coherer was far more compact, efficient and effective than the ones used in Europe. On 29 March 1904 he became the first Indian to get a US patent, for his "detector for electrical disturbances".

He also demonstrated a new type of radio waves as small as 1 centimeter to 5 millimeters. Such waves are now called microwaves, and are used in radars, ground telecommunication, satellite communication, remote sensing and microwave ovens. In May 1895, he read his first research paper before the Asiatic Society of Bengal 'On the polarisation of Electric Rays by Double Reflecting Crystals". In the same year one of his papers titled "On the Determination of the Indices of Refraction of Sulphur for the Electric Ray" was communicated to the Royal Society of London by Lord Rayleigh.

J. C. Bose was sent to England to get enrolled into Indian Civil Service. He took interest in Botany and Zoology. J. C. Bose, as Assistant Professor and researcher in Physics discovered the following:

1) Generation of electro-magnetic waves of wavelengths 2mm to 5 mm
2) Common nature of electric response to all forms of stimulation.
3) He was the first to find a device that generated micro-waves of very short wavelength.

J. C. Bose attained his greatness in the field of Botany. He was the author of the world famous books.

- Response in the Living and Non-living
- The Nervous Mechanism of Plants

Recognition and Honours

In 1903 Bose was honoured with Commander of the Order of the Indian Empire (CIE) at Delhi by the British Government. He received in 1912 the Commander of the Star of India (CSI) at the Coronation of the British Emperor. He was knighted by the British Government in 1916. Bose was elected a fellow of the Royal Society (FRS) of London in 1928. Bose died on 23 November 1937. He was the

member of the Vienna Academy of Sciences, 1928 and President of the 14th session of the Indian Science Congress in 1927.

The 230-year-old Indian Botanic Garden, Kolkata was renamed as the Acharya Jagadish Chandra Bose Indian Botanic Garden in June 2009 in honour of J.C. Bose.

VIKRAM A SARABHAI

Vikram Ambalal Sarabhai was the main personality behind the launching of India's first satellite, 'Aryabhatta'. He is considered as the 'Father of the Indian Space Programme'. Vikram Ambalal Sarabhai had devoted their entire life to the progress of science in our country.

Sarabhai's name will remain inseparable from India's space programme. It was Sarabhai who put India on the international map in the field of space research. But then he made equally pioneering contributions in other fields. He worked in the fields of textiles, pharmaceuticals, nuclear power, electronics and many others incessantly till last.

Vikram Sarabhai was born on August 12, 1919 at Ahmedabad, Gujarat to Shri Ambalal Sarabhai and Smt. Sarladevi Sarabhai, in a family of Industrialists. His father Ambalal Sarabhai was an affluent industrialist and owned many mills in Gujarat.

He had his early education in a private school. Here the prevent atmosphere injected into the young by the seeds of scientific curiosity, ingenuity and creativity. From this school he proceeded to Cambridge for his college education and took the tripods degree from St. John's College in 1940. When World War II began, he returned home and joined as a research scholar under Sir C.V. Raman at the IISc, Bangalore. In September, 1942 Vikram Sarabhai married Mrinalini Sarabhai who was a celebrated classical dancer of India.

Achievements & Contribution

Vikram Sarabhai started his work on cosmic rays and built the necessary equipment with which he took measurements. He returned to Cambridge in 1945. In 1947 he was awarded the Ph. D. degree. The Physical Research Laboratory (PRL) was established in November 1947 in a few rooms in M.G. Science Institute of the Ahmedabad Education Society, which was founded by his parents. Subsequently, it got support from the Council of Scientific and Industrial Research (CSIR) and the Department of Atomic Energy.

Establishing Physical Research Laboratory

His interest in solar physics and cosmic rays led him to set up many observation stations around the country. Vikram Sarabhai established centers for scientific research in several places of India. He was instrumental in establishing the Physical Research Laboratory (PRL) in Ahmedabad. In this, he formed the 'Group for the Improvement of Science Education', in 1963. In the same year, he established the Nehru Foundation for Development, for the study of social and education problems.

In 1966, under its auspices, he established the Community Science Center, whose object was to spread scientific knowledge, to create interest in science and to promote experimentation among students, teachers and the general public. After the sudden death of Dr. Sarabhai in 1971, the then Prime Minister of India, Smt. Indira Gandhi, renamed the Centre as the Vikram A. Sarabhai Community Science Centre, to associate its name with that of its founder.

To train efficient managers of factories, he started the Indian Institute of Management (IIM) at Ahmedabad. Of all the institutions, he established the most important were the 'Indian Space Research Organization' with Centers at Thumba, Ahmedabad, Shriharikota and Arvi. He established Rocket Launching Stations at Thumba and Shrihatikota. Along with his work on the science front, he took utmost interest and managed family business of Textiles and Pharmaceuticals.

He was also responsible for the Equatorial Rocket Building Station at Thumba. Sarabhai set up the Ahmedabad Textile Industries Research Association, a laboratory for research in physics and the Indian Institute of Management.

Effect of solar activity on cosmic rays

Sarabhai's study of cosmic rays under the eminent scientist Dr. C.V.Raman revealed that cosmic rays are a stream of energy particles

reaching the earth from the outer space, being influenced on their way by the sun, the atmosphere and magnetism. This study helps in observing terrestrial magnetism and the atmosphere, the nature of the sun and outer space.

By collecting and analysing his own observations as well as those of other scientists, Sarabhai's team concluded that meteorological effects could not entirely affect the observed daily variations of cosmic rays; further, the residual variations were wide and global and these were related to variations in solar activity.

In the observed cosmic ray anisotropies were to be regarded as modulation effect to the solar wind, then Sarabhai could visualize a new field of research opening up in solar and interplanetary Physics.

The first opportunity came in 1957-58 during the International Geo-physical year (IGY). The Indian program for the IGY had been one of the most significant ventures of Sarabhai. It exposed him to the new vistas of space science with the launching in 1957 of Sputnik-I. Subsequently, the Indian National Committee for Space Research was created, of which Sarabhai became Chairman.

Soaring to Space

The establishment of the Indian Space Research Organisation (ISRO) was one of his greatest achievements. He successfully convinced the government to the importance of a space programme for a developing country like India after the Russian Sputnik launch.

Rocket Launching Station: Dr. Homi Jehangir Bhabha, supported Dr. Sarabhai in setting up the first rocket launching station in India. The Rocket Launching station (TERLS) was established at Thumba near Thiruvananthapuram on the coast of the Arabian Sea, primarily because of its proximity to the equator. After a remarkable effort in setting up the infrastructure, personnel, communication links, and launch pads, the inaugural flight was launched on November 21, 1963 with a sodium vapour payload.

To implement the space programme, Sarabhai took the following steps during 1961-1966. Expanding PRL and making it the headquarters for Space activities. Setting up the Space Science and Technology Center at Thumba for creating fabrication, testing and other auxiliary facilities. Establishing an Experimental Satellite Communication Earth Station at Ahmedabad.

In 1965, the UN General Assembly gave recognition to TERLS as an international facility. With the sudden death of Homi Bhabha in an air crash, Sarabhai was appointed Chairman, Atomic Energy Commission in May 1966.

As a result of Dr. Sarabhai's dialogue with NASA in 1966, the Satellite Instructional Television Experiment (SITE) was launched during July 1975-July 1976 (when Dr. Sarabhai was no more). Dr. Sarabhai started a project for the fabrication and launch of an Indian Satellite. As a result, the first Indian satellite, Aryabhatta, was put in orbit in 1975 from a Russian Cosmodrome. This development furthers the indigenous capability for satellite launching from low-orbiting to synchronous levels.

Like Bhabha, Sarabhai wanted the practical application of science to reach the common man. Thus he saw a golden opportunity to harness space science to the development of the country in the fields of communication, meteorology, remote sensing and education. Vikram Sarabhai died at the age of 52 on December 31, 1971 at Kovalam, Thiruvananthapuram in Kerala.

Some of the most well-known institutions established by Sarabhai are :-

1. Physical Research Laboratory (PRL), Ahmedabad
2. Indian Institute of Management (IIM), Ahmedabad
3. Community Science Centre, Ahmedabad
4. Darpan Academy for Performing Arts, Ahmedabad (alongwith his wife)
5. Vikram Sarabhai Space Centre, Thiruvananthapuramm
6. Space Applications Centre, Ahmedabad
7. Faster Breeder Test Reactor (FBTR), Kalpakkam
8. Varaiable Energy Cyclotron Project, Kolkata
9. Electronics Corporation of India Limited (ECIL), Hyderabad

10. Uranium Corporation of India Limited (UCIL), Jaduguda, Jharkhand

Recognition and Honours

Sarabhai was President of the Physics section of the Indian Science Congress (1962), President of the General Conference of the I.A.E.A., Vienna (1970), Vice-President, Fourth U.N. Conference on `Peaceful uses of Atomic Energy' (1971).

Sarabhai was the second chairman of India's Atomic Energy Commission and the Indian Space Research Organization (ISRO). He was conferred 'Padma Vibhushan' in 1972. He was also awarded 'Dr. Shanti Swarup Bhatnagar Medal in Physics' in 1962.

PROF. SATISH DHAWAN

Prof. Satish Dhawan was an Indian rocket scientist who was born on September 25, 1920, in Srinagar, India. He is considered by the Indian scientific community to be the father of experimental fluid dynamics research in India and one of the most eminent researchers in the field of turbulence and boundary layers. "His father was a high-ranking civil servant of undivided India and retired as the resettlement Commissioner of Government of India at the time of partition. He completed graduation from the University of Punjab in Lahore, Pakistan. He also completed B.A. in Mathematics and physics, and M.A. in English Literature and a B.E. in Mechanical Engineering. In 1947, he obtained an M.S. in Aeronautical Engineering from the University of Minnesota. Later, he moved to the California Institute of Technology, where he was awarded the Aeronautical Engineer's Degree in 1949, and a Ph. D in Aeronautical and Mathematics in 1951, which he pursued with eminent aerospace scientist Professor Hans W. Liepmann as adviser.

Achievements & Contribution

After completion of education he joined the Indian Institute of Science in 1951 and became its Director in 1962. In 1972, he was appointed Chairman of the Space Commission and of the Indian Space Commission and of the Indian Space Research Organization (ISRO), and Secretary to the Government of India in the Department of Space. In the following decade, he directed the Indian space programme through a period of extraordinary growth and spectacular achievement. Major Programmes were carefully defined and systematically executed, including in particular the launch of Indian satellites on Indian rocket vehicles.

Even while he was the head of the Indian space programme, he devoted substantial efforts towards boundary layer research. His most important contributions are presented in the seminal book Boundary Layer Theory by Hermann Schlichting. "He was a popular professor at the Indian Institute of Science, (IISc) located in Bangalore. He is credited for setting up the first supersonic wind tunnel in India at IISc. He also pioneered research on relaminarization of separated boundary layer flows, three-dimensional boundary layers and trisonic flows.

Prof. Satish Dhawan carried out pioneering experiments in rural education, remote sensing and satellite communications. His efforts led to operational systems like INSAT- a telecommunications satellite, IRS - the Indian Remote Sensing satellite and the Polar Satellite Launch Vehicle (PSLV) that placed India in the league of space faring nations.

These projects were all distinguished by their keen sensitivity to the true needs of a developing nation, a confident appreciation of the ability of its scientists and engineers, and the carefully planned involvement of Indian space programme came to be seen in the 1980s as a model of technology development and application carried out within the country.

Recognition and Honours

Following the death of Prof. Satish Dhawan on January 3, 2002, the Indian satellite launch centre at Sriharikota, Andhra Pradesh, located about 100 km north of Chennai in South India was renamed as the Prof. Satish Dhawan Space Centre.

Prof. Satish Dhawan received many awards for his contribution to science and technology, few of them are as:

- Padma Vibhushan Award, (India's second highest civilian honour), in 1981.
- Indira Gandhi Award for National Integration, in 1999.

- Distinguished Alumnus Award, Indian Institute of Science.
- Distinguished Alumnus Award, California Institute of Technology, 1969.

SUBRAHMANYAN CHANDRASEKHAR

The 'Nobel Laureate' in physics Subrahmanyan Chandrasekhar was one of the greatest scientists of the 20th century became a legend in his life time. He was a great scientist, an accomplished teacher and a formidable scholar. Subrahmanyan Chandrasekhar was born in Lahore on October 19, 1910. His father C. Subrahmanyan Iyer was in Government Service.

C.V. Raman, the first Indian to get Nobel Prize in science was the younger brother of Chandrasekhar's father. Chandrasekhar grew up in Madras (now Chennai). He went to a regular school when he was eleven. He joined the Madras Presidency College in 1925 where in the first two years he studied Physics, Chemistry, English and Sanskrit. On July 31, 1930 Chandrasekhar left for England for higher studies and thus began a long and outstanding scientific career which spanned 65 years. Except for the first six years he worked at the University of Chicago.

Achievements & Contribution

Chandrasekhar was renowned for his work in the field of stellar evolution, and in the early 1930s, he was the first to theorise that a collapsing massive star would become an object so dense that not even light could escape it, now known as the Black hole. He demonstrated that there is an upper limit (known as 'Chandrasekhar Limit') to the mass of a White dwarf star. His theory challenged the common scientific notion of the 1930s that all stars, after burning up their fuel, became faint, planer-sized remmants known as white dwarfs. But today, the extremely dense neutron stars and black holes implied by Chandrasekhar's early work are a central part of the field of astrophysics.

He is best known for his celebrated discovery of Chandrasekhar Limit. He showed that there is a maximum mass which can be supported against gravity by pressure made up of electrons and atomic nuclei. The value of this limit is about 1.44 times a solar mass. This was derived by Chandrasekhar in 1930, when he was a student. The Chandrasekhar Limit plays a crucial role in understanding the stellar evolution. If the mass of a star exceeded this limit, the star would not become a white dwarf. It would continue to collapse under the extreme pressure of gravitational forces. The formulation of the Chandrasekhar Limit led to the discovery of neutron stars and black holes. It may be noted that stars are stable, that is they do not collapse because internal pressures (due to the thermal motion of the atomic nuclei and electrons and also the pressure of the radiation generated by nuclear reactions) balance gravity.

However, for every star a time will come when nuclear reactions will cease and that means there will be no internal pressure to match the gravitational pull. Depending on the mass there are three possible final stages of a star - white dwarf, neutron star and black hole.

Recognition and Honours

Chandrasekhar was awarded (jointly with the nuclear astrophysicist W.A. Fowler) the Nobel Prize in Physics in 1983. While Chandrasekhar is best known for Chandrasekhar Limit, for him there was no limit. His work spanned physics, astrophysics and applied mathematics.

The genius Subrahmanyan Chandrasekhar, known to the world as Chandra, died on August 21, 1995 in Chicago, Illinois, USA.

DR. HAR GOBIND KHORANA

Har Gobind Khorana was born on January 9th, 1922 in Raipur, Punjab, which is now part of eastern Pakistan. He is the youngest of a family of one daughter and four sons. His father was a 'patwari', a village agricultural taxation clerk in the British Indian system of government.

Har Gobind Khorana did his schooling from the D.A.V. High School in Multan (now West Punjab, Pakistan). Later, he studied at the Punjab University in Lahore where he obtained an M. Sc. degree.

Khorana lived in India until 1945, when the award of a Government of India Fellowship made it possible for him to go to England and he studied for a Ph. D. degree at the University of Liverpool. Roger J. S. Beer supervised his

research, and, in addition, looked after him diligently. It was the introduction of Khorana to Western civilization and culture.

Contributions and Achievements:

Khorana spent a postdoctoral year (1948-1949) at the Eidgenössische Technische Hochschule in Zurich with Professor Vladimir Prelog. The association with Professor Prelog molded immeasurably his thought and philosophy towards science, work, and effort.

After a brief period in India in the fall of 1949, Khorana returned to England where he obtained a fellowship to work with Professor G. W. Kenner and Lord A.R. Todd. He stayed in Cambridge from 1950 till 1952. Again, this stay proved to be of decisive value to Khorana. Interest in both proteins and nucleic acids took root at that time.““A job offer in 1952 from Dr. Gordon M. Shrum of the University of British Columbia took him to Vancouver. The British Columbia Research Council offered at that time very little by way of facilities, but there was 'all the freedom in the world' to do what the researcher liked to do.

During the following years, with Dr. Shrum's inspiration and encouragement and frequent help and scientific counsel from Dr. Jack Campbell, a group began to work in the field of biologically interesting phosphate esters and nucleic acids. Among the many devoted and loyal colleagues of this period, there should, in particular, be mention of Professor Gordon M. Tener, who contributed much to the spiritual and intellectual well-being of the group.““In 1960 Khorana moved to the Institute for Enzyme Research at the University of Wisconsin. He became a naturalized citizen of the United States. As of the fall of 1970 Khorana was appointed Alfred P. Sloan Professor of Biology and Chemistry at the Massachusetts Institute of Technology.

Dr. Har Gobind Khorana shared the Nobel Prize for Medicine and Physiology in 1968 with Marshall Nirenberg and Robert Holley for cracking the genetic code. They established that this code, the biological language common to all living organisms, is spelled out in three-letter words: each set of three nucleotides codes for a specific amino acid. Dr. Khorana was also the first to synthesize oligonucleotides (strings of nucleotides). Today, oligonucleotides are indispensable tools in biotechnology, widely used in biology labs for sequencing, cloning and genetic engineering.

Recognition and Honours

Dr. Har Gobind Khorana shared the Nobel Prize for Medicine and Physiology in 1968 with Marshall Nirenberg and Robert Holley. Khorana has won many awards and honors for his achievements, amongst them the Padma Vibhushan, Membership of the National Academy of Sciences, USA as well as a Fellow of the American Association for the Advancement of Science. H. Gobind Khorana died on 9 November 2011.

HOMI JEHANGIR BHABHA

Homi Jehangir Bhabha is mostly known as the chief architect of India's nuclear programme. Homi Jehangir Bhabha was a multifaceted personality - scientist, visionary and institution builder. He was born on October 30, 1909 in a Parsi family of Bombay (now Mumbai).

After finishing schooling, Bhabha's parents sent him to Cambridge University, UK for higher education in mechanical engineering. In 1930, Bhabha completed mechanical engineering in first class and stay for the degree in physics. After completing his degree in 1932, Bhabha continued his research at Cambridge University.

Contributions and Achievements:

Bhabha's first paper appeared in 1934, based on theoretical explanation of shower production in cosmic rays. His name is associated with Bhabha scattering, which involves relativistic exchange scattering of electrons and Bhabha-Heitler theory, dealing with production of electron and positron showers in cosmic rays. Thus, it was no surprise that at an young age of 31, he was elected as a fellow of the Royal Society, London. Bhabha rubbed shoulders with great physicists like Bohr, Pauli, Dirac, Cockcroft and others, who later became Noble Laureates.

Bhabha was on vacation during 1939, when the second world war broke out and he could not go back abroad to continue his research. He then joined Indian Institute of Science, Bangalore as a Reader in Department of Physics, headed by Sir C. V. Raman and set up a cosmic ray research unit.

In 1944, Bhabha wrote his historical letter to the Tata trust for support in setting up a centre for research work in nuclear science, which could play a central role in the development of nuclear energy. This was just two years after 1942, when the first experimental demonstration of nuclear reactor was made in USA.

All the more so, the country was still under the British rule and industrially undeveloped. There was a clear similarity in vision between the great Jamshedji Nusserwanji Tata and Bhabha with respect to the need for education, scientific research and human resource development for economic prosperity. Based on this letter, Tata Trust supported him to set up a laboratory at Kenilworth, Bombay. Subsequently, Tata Institute of Fundamental Research was formed and large scale research in physics, chemistry, electronics and mathematics commenced. Thus, Bhabha had converted the difficulty of not going back abroad to a great opportunity of setting up of front ranking research facilities within the country.

Creation of Atomic Energy Commission:

Bhabha was instrumental for the formation of Atomic Energy Commission in 1948 and the Department of Atomic Energy in 1954 and he chalked out a focussed research and minerals exploration programmes for nuclear energy. He was such a visionary that he had realized the importance of nuclear power programme way back in 1950s and enunciated a three stage nuclear programme so as to meet the energy security of the nation. It consisted of utilization of natural uranium, plutonium and abundant thorium resources in thermal, fast and advanced nuclear reactors with closed fuel cycle.

He also had balanced perspective on the role of other energy resources such as coal, oil and solar. A significant factor that contributed for the growth of nuclear sciences and its applications was Bhabha's rapport with the then Prime Minister Pandit Jawaharlal Nehru, who reposed complete confidence in him. This was possible because Bhabha had the deserving credentials and his passion matched with Nehru's vision of modern India. There was a great synergy in thinking between Nehru and Bhabha with respect to industrialization and scientific research, evolving hand-in-hand.

Bhabha gave utmost importance to the development of quality human resources. The commencement and continuation of BARC Training School for the scientific manpower over the last 50 years is a real tribute to Bhabha's foresight on quality manpower.

Bhabha, a person of perfection, purpose and excellence, ensured these qualities in all his endeavours viz., research, management, buildings and environment. Bhabha was a great scientific manager and followed the mantra of right man for the right job.

Recognition and Honours

Bhabha had received many prestigious national and international awards and recognitions. In 1954, he was conferred with Padma Bhushan award for outstanding contributions to nuclear science. In 1955, he was elected as the President of the first International Conference on the 'Peaceful Uses of Atomic Energy', organized by the UN at Geneva.

At a young age of 56, Bhabha suddenly passed away in 1966 due to a plane crash in Switzerland.

SRINIVASA RAMANUJAN

Srinivasa Ramanujan, Indian mathematician, whose contributions to the theory of numbers includes pioneering discoveries of the properties of the partition function. Srinivasa Ramanujan Aiyangar was an Indian Mathematician who was born in Erode, Tamil Nadu on December 22, 1887. Ramanujan is very well known for his efforts on continued fractions and series of hypergeometry. When Ramanujan was thirteen, he could work out Loney's Trigonometry exercises without any help. At the fourteen, he was able to acquire the theorems of cosine and sine given by L. Euler. Synopsis of Elementary Results in Pure and Applied Mathematics by George Shoobridge Carr was reached by him in 1903. The book helped him a lot and opened new dimensions to him which helped him introduce about 6,165 theorems for himself.

As he had no proper and good books in his reach, he had to figure out on his own the solutions for all the questions. It was in this quest that he discovered many tremendous methods and new algebraic series.

In 1904, he received a merit scholarship in a local college and became more indulgent into mathematics. He lost his interest in all other subjects due to which he lost his scholarship.

Contributions and Achievements:

In 1911 Ramanujan published the first of his papers in the Journal of the Indian Mathematical Society. His genius slowly gained recognition, and in 1913 he began a correspondence with the British mathematician Godfrey H. Hardy that led to a special scholarship from theUniversity of Madras and a grant from Trinity College, Cambridge. Ramanujan traveled to England in 1914, where Hardy tutored him and collaborated with him in some research.

Hardy said Ramanujan could have become an outstanding mathematician if his skills had been recognized earlier. It was said about his talents of continued fractions and hypergeometric series that, "he was unquestionably one of the great masters." It was due to his sharp memory, calculative mind, patience and insight that he was a great formalist of his days. But it was due to his some methods of working in the work analysis and theories of numbers that did not let him excel that much.

Ramanujan's knowledge of mathematics (most of which he had worked out for himself) was startling. Although almost completely ignorant of what had been developed, his mastery of continued fractions was unequaled by any living mathematician. He worked out the Riemann series, the elliptic integrals, hypergeometric series, the functional equations of the zeta function, and his own theory of divergent series. On the other hand, the gaps in his knowledge were equally startling. He knew nothing of doubly periodic functions, the classical theory of quadratic forms, or Cauchy's theorem, and had only the most nebulous idea of what constitutes a mathematical proof.

In England, Ramanujan made further advances, especially in the partition of numbers. His papers were published in English and European journals, and in 1918 he became the first Indian to be elected to the Royal Society of London.

Ramanujan published some of his results in journals, and many are beautiful indeed. However, his working notebooks contained much additional unorganized material which remained uninvestigated until the sustained efforts of Berndt and his coworkers who systematically examined and proved Ramanujan's sometimes vague or ambiguous statements. For anyone with a little knowledge of number theory, Ramanujan's notebooks make absolutely fascinating reading. It is therefore a great pity that their publisher, Springer-Verlag, has chosen to price these slim volumes at the ridiculous price of about $100 apiece.

Srinivasa Ramanujan hailed as an all-time great mathematician, like Euler, Gauss or Jacobi, for his natural genius, has left behind 4000 original theorems, despite his lack of formal education and a short life-span.

Hardy–Ramanujan number:

The number 1729 is known as the Hardy–Ramanujan number after a famous anecdote of the British mathematician G.H. Hardy regarding a visit to the hospital to see Ramanujan. Hardy said ''I remember once going to see him when he was ill. I had ridden in taxi cab number 1729 and remarked that the number seemed to me rather a dull one, and that I hoped it was not an unfavorable omen. "No," he replied, "it is a very interesting number; it is the smallest number expressible as the sum of two cubes in two different ways."

The two different ways are:

$$1729 = 1^3 + 12^3 = 9^3 + 10^3.$$

Generalizations of this idea have created the notion of "taxicab numbers". Coincidentally, 1729 is also a Carmichael number.

Recognition and Honours

He got elected as the fellow in 1918 at the Trinity College at Cambridge and the Royal Society. He died on April 26, 1920.

On the 125th anniversary of his birth, Government of India declared the birthday of Ramanujan, December 22, as 'National Mathematics Day' and the year 2012 celebrated as the National Mathematics Year.

MEGHNAD SAHA

Meghnad Saha was a great Indian scientist. He made remarkable contribution to the field of

Astrophysics. He put forward an "ionization formula" which explained the presence of the spectral lines. Meghnad Saha belonged to a poor family and struggled to rise in life. He was born in Seoratali, Dacca district, now in Bangladesh, on October 6, 1893.

Meghnad Saha took admission in the Kishorilal Jubilee School and passed the Entrance examination of the Calcutta University in 1909, standing first among the student from East Bengal obtaining the highest marks in languages (English, Bengali and Sanskrit combined) and in Mathematics. In 1911, he ranked third in the ISc exam while the first position went to another great scientist Satyendranath Bose. After that he took admission in Presidency College, Calcutta (now Kolkata). In 1913, he graduated from Presidency College with Mathematics major and got the second rank in the first one. In 1915, both S. N. Bose and Meghnad Saha ranked first in M.Sc. exam, Meghnad Saha in Applied Mathematics and S.N. Bose in Pure Mathematics.

Contributions and Achievements:

In 1917, he started his professional career and joined as lecturer at the newly opened University College of Science in Calcutta. He taught Quantum Physics. Along with S.N. Bose, he translated the papers published in German by Einstein and Hermann Minkowski on relativity into English versions. In 1919, American Astrophysical Journal published – "On Selective Radiation Pressure and its Application" – a research paper by Meghnad Saha. He put forward an "ionization formula" which explained the presence of the spectral lines. The formula proved to be a breakthrough in astrophysics. He went abroad and stayed for two years. He spent time in research at Imperial College, London and at a research laboratory in Germany.

In 1932, Meghnad Saha moved to Allahabad University and Uttar Pradesh Academy of Science was established in 1932. He returned to Science College, Calcutta in 1938. During this time, Saha got interested in Nuclear physics. In 1947, he established Institute of Nuclear Physics which later was named after him as Saha Institute of Nuclear Physics.

Having seen cyclotrons used for research in nuclear physics abroad, he ordered one to be installed in the institute. In 1950, India had its first cyclotron in operation. He invented an instrument to measure the weight and pressure of solar rays. He produced the famous equation, which he called 'equation of the reaction-isobar for ionization', which later became known as Saha's "Thermo-Ionization Equation".

Saha was the leading spirit in organizing the scientific societies like the 'National Academy of Science' (1930), 'Indian Institute of Science' (1935), and the 'Indian Association for the Cultivation of Science' (1944). The lasting memorial to him is the 'Saha Institute of Nuclear physics' founded in 1943 in Calcutta.

He was the chief architect of river planning in India. He prepared the original plan for Damodar Valley Project. For the sake of development of science he joined politics and in 1952 he was elected as a Member of Parliament for the North-West Calcutta constituency. He was an advocate for the peaceful use of nuclear energy and instrumental in the reformation of the Indian calendar. He died on February 16, 1956 due to a heart attack.

Recognition and Honours

Meghnad Saha was an Indian astrophysicist who nominated for the 'Nobel prize' in physics in 1935-36. In 1927, Meghnad was elected as a fellow of London's Royal Society.

In 1947, he established Institute of Nuclear Physics which later was named after him as Saha Institute of Nuclear Physics. He took the first effort to include Nuclear Physics in the curriculum of higher studies of science.

RAJA RAMANNA

Raja Ramanna was a multifaceted personality – an eminent nuclear physicist, a highly accomplished technologist, an able administrator, an inspiring leader, a gifted musician, a scholar of Sanskrit literature and philosophy. He made important contributions, both theoretical and experimental, in various areas of nuclear physics.

Following the ideals of his illustrious predecessors Homi Bhabha and Vikram Sarabhai in India's nuclear energy programme, Ramanna played an important role in placing the country's indigenous nuclear capabilities on

a firm footing and in this process his contributions towards shaping India's energy and security programmes are quite significant. In fact Ramanna is regarded as one of the most successful creators of Science and Technology in India.

Ramanna's contribution to India's peaceful nuclear explosion experiment is well-known. India's first peaceful nuclear experiment was carried out underground in the Rajasthan desert, Pokhran, on May 18, 1974.

Ramanna was born in Tumkur in Karnataka on January 28, 1925. His father, B. Ramanna, was in the judicial service of the Mysore state. He had his early education in Mysore and Bangalore. After completing his intermediate studies at St Joseph's, Bangalore he joined the Madras Christian College in Tambaram. After obtaining his BSc (Honours) degree in physics from Madras Christian College in Tambaram, he went to England to work for his doctoral in the field of nuclear physics at the King's College, London, as Tata Scholar. He obtained his PhD degree in 1948. Ramanna was deeply influenced by Homi Jehangir Bhabha. Ramanna died on 24th September, 2004 at Mumbai after a cardiac arrest.

Achievements & Contribution

Ramanna made important contributions in several areas of neutron, nuclear and reactor physics. Ramanna played a leading role in organizing physics and rector physics programmes at the Bhabha Atomic Research Centre, Trombay. Ramanna was a young reactor physicist in the team under Bhabha, when India's first research reactor, Apsara, was commissioned on August 04, 1956.

As a part of the studies relating to the design and construction of Apsara, Ramanna studied the process of neutron thermalisation in several moderating assemblies. Ramanna and his group determined the neutron diffusion and slowing down constants in water and beryllium oxide by using a pulsed neutron source. The neutron spectra emerging out of these moderating assemblies were also studied.

Apsara, once commissioned, made intense thermal neutron beams available for basic research. This prompted Ramanna to undertake a programme of experimental investigations of secondary radiations emitted in thermal neutron-induced fission of U235.

Ramanna and his coworkers measured the energy and angular distributions of prompt neutrons and gamma rays emitted by fission fragments. Such measurements provided important information on the times of these radiations, presence of scission neutrons, the average spin of the fission fragments and so on. The investigations carried out by Ramanna and his coworkers on light charged particle emission in fission induced by thermal and fast neutrons provided important insight on the mechanism of emission of these particles.

The stochastic theory of fragment mass and charge distributions in fission is a unique contribution of Ramanna to fission theory. The theory, which was based on the model of a random exchange of nucleons between the two nascent fission fragments prior to scission, could explain most of the observed features of fragment mass and charge distribution in low energy fission and their dependence on the excitation energy of the fissioning nucleus. A geometrical interpretation of atomic and nuclear binding energies was another novel contribution of Ramanna and his group.

Ramanna's most important contribution was the creation of a vast pool of trained scientific manpower. To develop the skilled manpower required for this task, the BARC (DAE) Training School was established in 1957 under the leadership of Ramanna.

Ramanna directly or indirectly helped to build up a number of institutions in the country. In the early 1980s he took the initiative for setting up a Centre for Advanced Technology at Indore, devoted to the development for advanced accelerators, lasers and other related technologies. He helped to establish the Variable Energy Cyclotron Centre (VEC) at Kolkata.

Recognition and Honours

Raja Ramanna was an able administrator. He held many prestigious positions. He was the Director of the Bhaba Atomic Research Centre (1972-78 and 1981-83). He was Scientific Advisor to the Minister of Defence; Director-General, DRDO and Secretary for Defence

Research, Government of India (1978-81). He was Chairman of the Atomic Energy Commission (1984-87). He was first Director of the National Institute of Advanced Studies, Bangalore established by J. R. D. Tata and President, 30th General Conference of the International Atomic Energy Agency (1986).

Ramanna served as the Minister of State for Defence in the Union Cabinet (January to November 1990). Ramanna was a nominated Member of the Parliament, Rajya Sabha, (August 1997-August 2003). He was a member of the first National Security Advisory Board. In whichever capacity he worked, he worked with a missionary zeal.

Among the various awards that he received included: Shanti Swarup Bhatnagar Award (1963), Padma Vibhushan Award (1975), Meghnad Saha Medal of the Indian National Science Academy (1984), R. D. Memorial Award (1985-86), Asutosh Mookerjee Gold Medal (1996). He was awarded doctorate (honoris causa) by several universities.

DR. SALIM ALI

Salim Moizuddin Abdul Ali was one of the greatest ornithologists and naturalists of all time and is also known as the "Birdman of India". He was one of the very first scientists to carry out systematic bird surveys in India and abroad. His research work is considered highly influential in the development of ornithology. Dr. Sálim Ali is also known as the father of Indian ornithology.

Salim Ali was born on November 12, 1896 in Bombay (now Mumbai). He attended college, but did not receive any university degree. To assist his brother in wolfram mining, he went to Burma (now called Myanmar), but spent most of his time looking for birds. Soon, he returned back to Bombay.

This genius died on June 20, 1987 at the age of 90.

Contributions and Achievements:

For twenty years he camped and studied birds. With a notebook in his pocket and binoculars, he walked hundreds of miles. It was hard, scary, dangerous work.

As soon as Salim returned, he studied zoology, and secured a position of a guide at the museum of the Bombay Natural History Society. Only 20 years old, he conducted the visitors and instructed them about the preserved birds. His interest in the living conditions of birds grew even more. Therefore, Salim visited Germany and saw Dr. Irvin Strassman. He came back to India after one year but his post in the museum had been removed for financial reasons.

Salim Ali, as a married man, required money to make a living, so he joined the museum as a clerk. He published a research paper discussing the nature and activities of the weaver bird in 1930. The piece made him famous and established his name in the field of ornithology. Salim also traveled from place to place to find out more about different species of the birds.

From what he had collected, he published "The Book of Indian Birds in 1941? in which he discussed the kinds and habits of Indian birds. The book sold very well for a number of years. He also collaborated with S. Dillon Ripley, a world-famous ornithologist, in 1948. The collaboration resulted in the 'Handbook of the Birds of India and Pakistan' (10 Volume Set); a comprehensive book that describes the birds of the subcontinent, their appearance, habitat, breeding habits, migration etc. Salim also published other books. His work "The Fall of Sparrow" included many incidents from his real life.

Salim not only researched about birds, but also contributed to the arena of protection of nature. For his extraordinary efforts, he was given an international award of Rs. 5 lacs, but he donated all the money to Bombay Natural History Society. The Government of India honored him with Padma Vibushan in 1983.

National Wildlife Fellowship Award

In order to commemorate the memory of the great wildlife conservationist of the country, i.e., Dr. Salim Ali to inspire and promote, particularly the younger generation of wildlife managers and scientists for taking up research / experimental projects aimed at conservation of the rich wildlife heritage of this country, the Govt. of India, Ministry of Environment and Forests has decided to award the fellowship alternatively each year. Dr. Salim Ali National Wildlife Fellowship Award, 2011 for, Research / experimental project on avian wildlife is due for award.

DR. SHANTI SWAROOP BHATNAGAR

Dr. Shanti Swaroop Bhatnagar was a eminent Scientist of India. He was known as "The Father of Research Laboratories". Bhatnagar was born on February 21, 1894 in Shahpur, now in Pakistan. After completing his M. Sc. in India, he went to England on a fellowship. He got his D. Sc. degree from the London University in the year 1921, under the guidance of chemistry professor Frederick G. Donna. When he came back, Bhatnagar was presented with proposal of professorship at the renowned Banaras Hindu University.

Contributions and Achievements:

Though his area of interest included emulsions, colloids, and industrial chemistry, but his primary contributions were in the spheres of magneto- chemistry. Prime Minister Jawaharlal Nehru himself was an activist of scientific development. After India gained freedom from British rule in 1947, the Council of Scientific and Industrial Research was established under the leadership of Dr. Bhatnagar, who was appointed its first director-general. He became the first director-general of the Council of Scientific and Industrial Research (CSIR) in 1940.

He was known as the "The Father of Research Laboratories". He is largely remembered for having established various chemical laboratories in India. He also developed a total twelve national laboratories, just a few names are Central Food Processing Technological Institute, Mysore, the National Physical Laboratories, New Delhi, National Chemical Laboratory, Pune, the Central Fuel Institute, Dhanbad, and the National Metallurgical Laboratory, Jamshedpur.

He also played an important part with Homi Jehangir Bhabha, P .C. Mahalanobis, Vikram Sarabhai and others in building of post-independent S &T infrastructure and in the formulation of India's science and technology policies. He was the founder Director of the Council of Scientific and Industrial Research (CSIR) which later it became a major agency for research in India. He was also the Chairman of the University Grants Commission (UGC).

Bhatnagar was the Secretary of Ministry of Education and Educational Adviser to the Government. He played a major role both in the Constitution and Deliberations of the Scientific Manpower Committee Report of 1948. He was a University Professor for more than 19 years. He first worked at the Banaras Hindu University, then he moved to Punjab University, where he had a reputation as a very inspiring teacher.

His contribution in the areas of magneto-chemistry and physical chemistry of emulsion were largely recognized. He played an instrumental role in the establishment of the National Research Development Corporation (NRDC) of India, which brinsg coordination between research and development. He was responsible for the initiation of the Industrial Research Association movement in India.

Bhatnagar constituted the one-man Commission in 1951 to negotiate with oil companies for starting refineries and this ultimately led to the establishment of many oil refineries in different parts of the country. He induced many individuals and organizations to donate liberally for the cause of science and education. He exhibited high poetic talent particularly in Urdu. He died in 1st January 1955 at the age of 60 in New Delhi.

Recognition and Honours

Bhatnagar used to spend all his spare time in his laboratory doing research. Dr. Bhatnagar was knighted by the British Government in the year 1941 as an award for his research in science, whereas, on March 18, 1943 he was selected as fellow of the Royal Society. Bhatnagar was also a recipient of "Padma Vibhushan" in 1954. After his death, ASIR established a Bhatnagar Memorial award for eminent scientists in his honour.

Shanti Swarup Bhatnagar Prize

Shanti Swarup Bhatnagar (SSB) Prize for Science and Technology was instituted in the year 1957, in the memory of late Dr (Sir) Shanti Swarup Bhatnagar, FRS, the founder director of the Council of Scientific & Industrial Research (CSIR). The SSB Prize is awarded each year on the basis of conspicuously important and outstanding contributions to human knowledge and progress, made through work done primarily

in India during the five years, preceding the year of the prize. The SSB Prize comprises a citation, a cash award of Rupees 5,00,000/- and a plaque.

BIRBAL SAHNI

Birbal Sahni (1891- 1949) was a world famous palaeobotanist, who studied the fossils of the Indian subcontinent. He was born on 14th November 1891 at Bhera, Saharanpur District, now a part of West Punjab in Pakistan. He was the founder of Birbal Sahni Institute of Palaeobotany, which is situated in Lucknow.

He was the son of Ishwar Devi and Lala Ruchi Ram Sahani. His father was a chemistry teacher who was interested in the study of nature. He got his education from Punjab University, Lahore. Later on, in 1911 he went to England, where he entered the Emmanuel College at Cambridge. In 1913 Sahni obtained a first class in Part-I of the Natural Sciences Tripos and he completed the Part-II of the Tripos in 1915. After that he studied under Professor A.C. Seward, and got his D.Sc. Degree from Landon University in 1919.

Contributions and Achievements

After completion of his education Birbal Sahni came back to India and worked as Professor of Botany at Banaras Hindu University, Varanasi and Punjab University for about a year.

Palaeobotany is a subject which requires the knowledge of botany and geology subject. It also require for an daring guts and a physique good enough for trekking on the mountains for collection of rocks that contain plant fossils. Once the rocks have been collected and ground, the abilities of a detective are required to piece together the picture of that ancient plant from the scattered information available in the fossils. From childhood Sahni was interested in these qualities.

Birbal Sahni was the first botanist to study extensively the flora of Indian Gondwana. Sahni also explored the Rajmahal hills in Jharkhand, which is a treasury of fossils of ancient plants. Here he discovered some new genus of plants. His research contribution in palaeobotany covered such a vast range that no aspect of palaeobotany in India was left untouched by him. Amongst a large number of fossil plants described by him from Rajmahal Hills of Jharkhand, was his most remarkable discovery of a new group of fossil gymnosperms, to which he gave the name "Pentoxylae". Sahni studied Ptilophyllum and other related elements from Rajmahal Hills and found that stem Buaklandia, leaf Ptilophyllum and flower Williamsonia belong to the same plant which he reconstructed and named as Williamsonia sewardiana.

Birbal Sahni was not only botanist but also geologist. By using simple instruments and his huge knowledge of ancient plants, he estimated the age of some old rocks. He showed to the people that the age of the salt range, now in Pakistan Punjab, is 40 to 60 million years old and not about 100 million years, as believed till then. He found that the Deccan Traps in Madhya Pradesh were of the tertiary period, about 62 million years old. Besides, Sahni took a keen interest in archaeology. One of his investigations led to the discovery of coin moulds in Rohtak in 1936. For his studies on the technique of casting coins in ancient India he was awarded the Nelson Wright Medal of the Numismatic Society of India in 1945.

Palaeobotanical studies should be done in relation to the geological and geographical conditions under which the plants lived and died. He himself made important contributions in geological studies. He threw considerable light on problems like the age of the Deccan Traps, the Saline Series and the timing of the Himalayan uplift.

Being a teacher, Sahni first raised the standard of teaching at the Department of Botany. Next he established the Department of Geology. A logical sequence was the establishment of the institute of palaeobotany. It was the first of its kind in the world.

Recognition and Honours

Because of abiding interest in geology and his fundamental contributions to the study of plant life in the past, Birbal Sahni was recognized by several academies and institutions in India and abroad. He was elected a Fellow of the Royal Society of London (FRS) in 1936, the highest British scientific honor, awarded for the first time to an Indian botanist. He was elected Vice-President, Palaeobotany section, of the

International Botanical Congresses of 1930 and 1935, respectively; General President of the Indian Science Congress for 1940; President, National Academy of Sciences, India, 1937–1939 and 1943-1944. In 1948 he was elected an Honorary Member of the American Academy of Arts and Sciences. Another high honour which came to him was his election as an Honorary President of the International Botanical Congress, Stockholm in 1950.

Sahni died on 10th April, 1949 within less than a week of the foundation stone laying ceremony of his institute. His wife, Savitri Sahni, completed the task he had left undone. The institute is today known as the Birbal Sahni Institute of Palaeobotany. In November 1969 the Palaeobotanical Society divested its possession of the Institute and transferred its assets to Birbal Institute of Plaeobotany Society whereby the Birbal Sahni Institute of Palaebotany came under the management of its new Governing Body under the Department of Science and Technology, Government of India.

DR. A.P.J. ABDUL KALAM

Avul Pakir Jainulabdeen Abdul Kalam, popularly known as Dr. A.P.J. Abdul Kalam, served the country as the 11th President of India. It is very significant that he is the first scientist to occupy the Rashtrapati Bhavan. He is a man who has taken unto himself, the task of changing the destiny of India. He is a man with a vision. Dr. A.P.J. Abdul Kalam is often also referred to as the 'Missile Man of India'.

His vision is to make India a developed country. He has given his plan of action and a road map for realizing his vision. He has articulated his thoughts in his three books: India 2020: A Vision for the New Millennium, Wings of Fire: An Autobiography of A. P. J. Abdul Kalam and Ignited Minds: Unleashing the Power Within India.

Dr. Kalam was born on October 15, 1931, in a middle-class Tamil family in the island town of Rameswaram, Dhanushkodi, in Tamil Nadu.

Achievements & Contribution

After studying in a primary school in Ramaeswaran, Dr. Kalam went to Schwartz High School at Ramanathpuram from where he went to Tiruchchirapalli for his higher studies. After completing his BSc from St. Joseph's college he joined the Madras Institute of Technology (MIT), for studying aeronautical engineering. From MIT, he went to Hindustan Aeronautics Limited (HAL) at Bangalore as a trainee. As aeronautical engineer Dr. Kalam had two options -- in short, to join the Directorate of Technical Development and Production, or DTD & P (Air) of the Ministry of Defence or the Indian Air Force. As he could not make it to Indian Air Force, Dr. Kalam joined the Technical Centre (Civil Aviation) of the DTD&P (Air) as Senior Scientific Assistant on a basic salary of Rs. 250/ .

While working at the Air force Directorate he got a chance to realise his dream. He joined the Indian Committee for Space Research (INCOSPAR), the predecessor of the Indian Space Research Organisation (ISRO). And thus Dr. Kalam started his much talked about career in rocket and missile technology.

First Phase: Before he became President of the country, Dr. Kalam had divided his career in four phases. In the first phase (1963-82) he worked with the Indian Space Research Organisation (ISRO). At ISRO he served in various capacities. After initiating Fibre Reinforced Plastics (FRP) activities and spending some time with the aerodynamics and design group he joined the satellite launching vehicle team at Thumba. Here he was made the Project Director of the Mission for SLV-3. He played a crucial role in developing satellite launch vehicle technology and expertise in control, propulsion and aerodynamics. The SLV-3 project managed to put Rohini, a scientific satellite, into orbit in July 1980. India also acquired the ability to design various kinds of rocket systems.

Second Phase: The second phase of his career started when he joined the Defence Research and Development Organisation (DRDO) in 1982. As Director of DRDO, Dr. Kalam was entrusted with the Integrated Guided Missile Development Programme (IGMDP). Under his leadership India has been able to develop strategic missiles. Like Nag (an anti-tank guided missile), Prithvi (a surface to surface battlefield missile), Akash (a swift, medium - range surface-to-air missile), Trishul (a quick-reaction surface-to-air missile) and Agni (an

intermediate range ballistic missile). Three new laboratories / facilities in the area of missile technology were established.

Third Phase: Dr. Kalam identifies his third phase with his participation with India's mission to become a nuclear weapon state, jointly undertaken by DRDO and Department of Atomic Energy (DAE) with the active support of the armed forces. During this phase he, as Chairman of the Technology Information, Forecasting and Assessment Council (TIFAC), also got involved with the creation of Technology Vision 2020 and the India Millennium Missions (IMM 2020), which is an integratied version of technology vision and India's security concerns. In November 1999 Dr. Kalam was appointed as Principal Scientific Adviser to the Government of India.

Fourth Phase: His fourth phase started after he left the post of Principal Scientific Adviser. He joined the Anna University at Chennai as Professor of Technology and Societal Transformation. As part of realizing his mission he decided to ignite the minds of the young. For this purpose he wanted to reach at least 100,000 students in different parts of the country before August 2003. He has already met about 40,000 students. His fourth phase took a sudden turn, which he himself perhaps did not visualize: He became the President of India.

Other field of Interest

Kalam continues to take an active interest in other developments in the field of science and technology as well. He has proposed a research programmed for developing bio-implants. He is a supporter of pen source software over proprietary solutions and believes that the use of open source software on a large scale will bring more people the benefits of Information Technology.

Dr. APJ Abdul Kalam regards his work on India's nuclear weapons program as a way to assert India's place as a future superpower. Even during his tenure as president, APJ Kalam took avid interest in all spheres of India's science and technology. He has even put forward a project plan for establishing bio-implants. He is also an ardent advocate of open source software over proprietary solutions to churn out more profits in the field of information technology in India.

Recognition and Honours

In 1997 Dr. APJ Kalam was given the highest civilian award of India, the Bharat Ratna. Dr. Kalam became the President of India on July 25, 2002.

DR. LALJI SINGH

Dr. Lalji Singh is one of the eminent scientists of the country and served as the 25th Vice-Chancellor of Banaras Hindu University (BHU), Varanasi. Born on 5th July, 1947 in Jaunpur, Uttar Pradesh, Dr. Singh rose to acquire the place among the premier scientists of India. He holds the position of Bhatnagar Fellow of CSIR at Centre for Cellular and Molecular Biology (CCMB), Hyderabad, of which he was Director for a long period of 11 years from 1998 to 2009. He spent 13 years in the Institute of Animal Genetics, University of Edinburgh (1974-1987) before joining CCMB.

Dr Lalji Singh obtained his M.Sc., and Ph.D (Cytogenetics) from Banaras Hindu University, which later awarded him Honorary degree of D.Sc. in the year 2004 and its Distinguished Alumnus Award in the year 2009. Dr. Lalji was awarded Ph.D. in 1971 for his work in the area of Cytogenetics and he worked on "Evolution of karyotypes in snakes".

Achievements & Contribution

Dr. Lalji Singh has an exemplary research and professional experience of around 45 years, during which he has published more than 219 research papers in internationally reputed journals, including a full article in 'Nature' (2009) which has been also covered on the cover page of 'Nature'.

In June 1987 Lalji came back to India and joined Centre for Cellular and Molecular Biology (CCMB), Hyderabad as senior scientist. His research interests include Molecular basis of Sex-determination; DNA Fingerprinting and genetic diversity; Wildlife Conservation; Silkworm Genome Analysis; Human Genome Analysis and Ancient DNA Studies.

Dr. Lalji Singh and his colleagues developed a probe called Bkm-derived probe for DNA fingerprinting which brought CCMB to limelight. Since then this probe is being extensively used for forensic investigation, paternity determination and seed stock verification.

For the first time in the annals of Indian history DNA fingerprinting evidence was presented in the court of law. This unique work of Lalji, prompted Government of India's Department of Biotechnology (DBT) to form autonomous institution "Centre for DNA Fingerprinting and Diagnostics (CDFD)" in 1995. Currently housed at CCMB, Lalji shouldered the responsibility of setting up of this new national facility. As its Officer-on-Special-Duty (OSD), Lalji worked towards development, acquisition and standardization of protocols for carrier detection, prenatal diagnosis and genetic counseling for all the genetic disorders prevalent within India.

In order to explore the tremendous potential of the indigenously developed technology of DNA fingerprinting, Dr. Lalji Singh has proposed, pursued and established a new centre, the Centre for DNA Fingerprinting and Diagnostics (CDFD) at Hyderabad under the Department of Biotechnology (DBT). In July 1998 he was appointed as the Director of the Centre for Cellular and Molecular Biology (CCMB), Hyderabad.

Based on the studies of Dr. Lalji Singh and his colleagues on Wildlife Conservation, Government of India has set up a "Laboratory for the Conservation of Endangered Species (LaCONES)" in Hyderabad. For regenerative medicine, Dr Singh has setup 'Clinical Research Facility (CRF)' in collaboration with NIMS. He is founder of 'Genome Foundation', a non-profit-making organization registered under Companies Act 25 in Hyderabad.

The social impact of some of the research works carried out by Dr. Singh include development of a Universal Probe for DNA fingerprinting, conservation of wildlife, species identification for forensic applications, DNA based molecular diagnostics and work on genetic affinities of Andaman islanders.

Recognition and Honours

The contribution of Dr. Lalji Singh has been profusely rewarded which include, apart from "Padmashri" by President of India in 2004, B P Pal Memorial Award at the 97th Indian Science Congress, 2010; Life Time Achievement Award for the year 2008 by the Biotech Research Society (BRSI), BHU, Varanasi; CSIR Technology Award for Life Sciences' 2008; Vigyan Gaurav Award of the Council of Science & Technology, Government of Uttar Pradesh (2003); Goyal Prize in Life Sciences (2000) and New Millennium Plaques of Honour Award 2001-2002 for outstanding services in the field of Biological Sciences presented by the Prime Minister of India at the 89th Session of the Indian Science Congress(2002) to name a few. He is also Fellow of the Third World Academy of Sciences, Trieste, Italy (2002).

M.S. SWAMINATHAN

India's well-known geneticist and international administrator, Monkombu Sambasivan Swaminathan was born on August 7, 1925 in Kumbakonam, Tamil Nadu. After preliminary education in Tamil Nadu, Swaminathan obtained his Ph D as a geneticist from Cambridge University, United Kingdom, in 1952. Popularly known as the Father of Green Revolution in India, the missionary of ever-green revolution continues to work for a hunger-free society.

His stated vision is to rid the world of hunger and poverty. Swaminathan is an advocate of moving India to sustainable development, especially using environmentally sustainable agriculture, sustainable food security and the preservation of biodiversity, which he calls an "evergreen revolution".

Contributions and Achievements:

After a two-year postdoctoral stint at the University of Wisconsin, USA, he returned to India and joined the Indian Agricultural Research Institute (IARI), New Delhi. It was from IARI that the 'wheat revolution' was choreographed during the 1960s. He is known for his contributions in wheat, rice, potato and jute genetics, after which he worked on Mexican dwarf wheat varieties and conservation of plant genetic resources.

He established the National Bureau of Plant, Animal and Fish Genetic Resources of India and the International Plant Genetic Resources Institute, besides serving as the Principal Secretary in the Ministry of Agriculture, Government of India.

During the next two decades he held a

number of research and administrative positions (mostly in the Indian civil service). While working in these positions he helped introduce Mexican semi-dwarf wheat plants to Indian fields and helped to bring about greater acceptance of modern farming methods. The seeds of 'Green Revolution' in India were sown in Punjab Agricultural University (PAU).

Recognition and Honours

From 1972 to 1979 he was director general of the Indian Council of Agricultural Research, and he was minister of Agriculture from 1979 to 1980. He served as director general of the International Rice Research Institute (1982–88) and became president of the International Union for the Conservation of Nature and Natural Resources in 1988.

Dr. Swaminathan has been recognized with a number of national and international awards, including Padma Shri (1967), Padma Bhushan (1972), Padma Vibhushan (1989), the Ramon Magsaysay Award for Community Leadership (1971), and the Albert Einstein World Award on Science (1986). He was the first laureate of the World Food Prize (1987) that is regarded as the Nobel Prize in Agriculture. He was also a nominated Member of Parliament (Rajya Sabha).

He was awarded the First World Food Prize in October 1987 and has been described by the United Nations Environment Programme as "the Father of Economic Ecology".

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1. MRAM Technology

A team of researchers, led by Dr Yang Hyunsoo, from the Department of Electrical & Computer Engineering at the National University of Singapore (NUS) Faculty of Engineering developed the new Magnetoresistive Random Access Memory (MRAM) technology that that enables bigger and longer lasting memory in electronics such as laptops and smartphones. The technology will drastically increase storage space and enhance memory which will ensure that fresh data stays intact, even in the case of a power failure.

The new technology can also be applied in transportation, military and avionics systems, robotics, etc. Currently pursued schemes with a very thin magnetic layer can only retain information for about a year. The innovation is expected to change the architecture of computers, making them much easier to manufacture as it does away with many facilities such as flash memory, effectively bringing down the cost.

MRAM is emerging as the next big thing in data storage as it is non-volatile, which means that data can be retrieved even when the electronic equipment is not powered up. The current methods of applying MRAM revolve round the technology which uses an 'in-plane', or horizontal, current-induced magnetisation.

This method uses ultra-thin ferromagnetic structures which are challenging to implement due to their thickness of less than 1 nanometre. Their manufacturing reliability is low and tends to retain information for only less than a year.

2. Indigenous Cervical Cancer Diagnostic Kit

The Union Health and Family Welfare Ministry launched AV Magnivisualizer, an indigenous device that can detect early cervical cancer and be used even by healthcare workers with basic training.

The device AV Magnivisualizer which was developed by the Institute of Cytology and Preventive Oncology under the Indian Council of Medical Research (ICMR) has 95 per cent accuracy for detecting pre-cancerous lesions. Randomised clinical control trials have confirmed its efficacy in reducing incidence and mortality of the disease. It can be made available in remote rural areas.

This is a user-friendly device which costs about Rs 10,000 as against the present devices which cost between Rs 8-10 lakh and are beyond the reach of most people.

The device has a white light source with variable interchangeable magnification and can be operated on a 12- volt battery in rural and semi-urban areas where electric supply is not regular. Magnivisualizer has been found to pick up 1.5 times more high-grade pre-cancerous lesions than the ordinary tungsten light.

AV Magnivisualizer would be available in the market within the next 8-9 months and efforts would be made to provide them up to the Community Health Centres in the initial phase. In the next phase it would be made available in the Primary Health Centres (PHC), where cervical cancer cases go undetected.

Cervical cancer is the most common malignancy among Indian women, particularly those who marry early. Current estimates indicate that approximately 1.32 lakh new cases are diagnosed and 74,000 deaths occur annually in India, accounting for nearly one-third of global cervical cancer deaths.

Cervical cancer takes about a decade to fully develop and is often detected when it has spread substantially. It starts from a pre-cancer stage called dysplasias and early detection and appropriate treatment at this stage can halt its progression, resulting in decreased incidence or mortality.

At present, cytology screening or Pap Smear

is available only in advanced cytology centres, Regional Cancer Centres and some medical colleges. The required infrastructure, trained manpower and related mechanism for initial screening are not available to carry out population-based screening at the State or the national level.

Worldwide Facts About Cervical Cancer

- ***Cervical cancer is the No. 1 women's cancer in sub-Saharan Africa and is the third most common cancer in women worldwide, with 530,000 new cases and 275,00 deaths annually.***
- ***Some 80 to 90 percent of women in sub-Saharan Africa have never had a pelvic exam.***
- ***More than 85 percent of the global burden of cervical cancer occurs in resource-limited countries, yet the World Health Organization estimates less than 5 percent of these women have access to screening even once in a lifetime.***
- ***Cervical cancer is four to five times more prevalent among women who are HIV-positive.***
- ***HPV vaccination offers a promising solution for women in developing nations who do not have access to screenings for cervical cancer, although the cost of the vaccination is a major barrier for many resource-limited countries.***
- ***Cervical cancer is the No. 1 cancer affecting women in 37 countries in South and Central America, west and southern Africa, and Asia.***
- ***Cervical cancer occurs in the cells of the cervix, the lower part of the uterus that connects to a woman's vagina. Various strains of the human papillomavirus (HPV), a sexually transmitted infection, are the culprits in causing most cases of cervical cancer.***
- ***Most women's immune systems prevent the HPV virus from turning cancerous. In a small percentage of women, however, the virus survives for years, and, if not detected and prevented, some cells on the surface of the cervix turn into cancer cells.***

3. Greenest Supercomputer

One of the world's greenest supercomputer has been created by Cambridge University. The energy-efficient high-performance computer, named Wilkes after Cambridge computing pioneer Maurice Wilkes, has been listed second in the 'Green 500'; placed 166 in the Top 500 list of the world's fastest supercomputers. It is the most efficient air-cooled supercomputer in the world and fastest GPU supercomputer in the UK.

The performance of Wilkes is equivalent to 4,000 desktop computers working at the same time; it has energy efficiency of 3,361 Mega-flops per watt; provides 100 gigabytes per-second bandwidth, and a message rate of over 137 million messages a second.

The supercomputer, designed and built by the in-house engineering team, will be used for the development of the Square Kilometre Array (SKA), the world's largest telescope.

Apart from playing a crucial role in the design process of SKA, the supercomputer can also be used to design and test jet engines and new drugs to fight cancer, and study the fundamental nature of the nucleus of the atom.

4. MAVEN launched by NASA

NASA has launched its unmanned MAVEN spacecraft towards Mars to study the Red Planet's atmosphere for clues as to why Earth's neighbour lost its warmth and water over time. The white Atlas V 401 rocket carrying the Mars Atmosphere and Volatile Evolution (MAVEN) orbiter blasted off on schedule time. MAVEN is the first spacecraft devoted to exploring and understanding the Martian upper atmosphere.

The flawless lift-off of the $671 million spacecraft kicked off the 10-month journey to the Red Planet. Arrival at Mars is scheduled for September 2014, with the science mission of the solar-wing panelled orbiter set to begin two months later.

One of its three scientific tools is a solar wind and ionosphere gauge called the Particles and Fields Package, built by the University of California at Berkeley Space Sciences Laboratory. A second tool, called the Remote Sensing Package, was built by the Laboratory for

Atmospheric and Space Physics at the University of Colorado and will determine global characteristics of the upper atmosphere and ionosphere. The third instrument, the Neutral Gas and Ion Mass Spectrometer, was built by NASA's Goddard Space Flight Center. It will measure the composition and isotopes of neutrals and ions.

The probe is different from past NASA missions because it focuses not on the dry surface but on the mysteries of the never-before-studied upper atmosphere. Much of MAVEN's year-long mission will be spent circling the planet 6,000 kilometers above the surface. However, it will execute five deep dips to a distance of just 125 kilometers above the Martian landscape to get readings of the atmosphere at various levels.

Researchers have described the mission as a search for a missing piece to the puzzle of what happened to Mars' atmosphere, perhaps billions of years ago, to transform Earth's neighbour from a water-bearing planet that might have been favourable for life to a dry, barren desert.

5. Mars Orbiter Mission

The mission objectives are both technological and scientific in nature. Here are some of the important objectives for ISRO.

- Design and realisation of a Mars orbiter with a capability to survive and perform Earthbound manoeuvres, cruise phase of 300 days, Mars orbit insertion / capture, and on-orbit phase around Mars.
- Deep space communication, navigation, mission planning and management.
- Exploration of Mars surface features, morphology, mineralogy and Martian atmosphere by indigenous scientific instruments.

Mission Facts

- The 1,337 kg Mars Orbiter Satellite will be put into a 250 km X 23,500 km elliptical orbit.
- The launch vehicle being used is a PSLV-C25.
- This is the 25th mission of PSLV and fifth in the XL configuration.
- Time from launch to injection of the Orbiter into its trajectory is about 40 minutes.
- The cost of the mission is approximately Rs. 450 crore.
- With this mission, India will be the first Asian country and the fourth in the world to take part in interplanetary exploration.

The Mars Orbiter payloads

Lyman Alpha Photometer(LAP): This device is an absorption cell photometer that will help determine the relative abundance of Deuterium and Hydrogen from Lyman-Alpha emission in the upper Martian atmosphere. The results from the device will mainly help us understand the loss process of water from Mars, among other things.

Mars Colour Camera(MCC): This tri-colour camera will provide information regarding the Martian surface like surface features and composition. It will also help monitor the dynamic events and weather on the planet. The camera will also monitor Phobos, and Deimos, the two satellites of mars.

Methane Sensor for Mars(MSM): This device will measure Methane(CH_4) in the planet's atmosphere and map its sources.

Mars Exospheric Neutral Composition Analyser(MENCA): This device is a mass spectrometer that can analyse neutral composition in the range of 1 to 300 amu with unit mass resolution.

Thermal Infrared Imaging Spectrometer(TIS): This device will measure the thermal emission both during day and night. TIS can also map surface composition and mineralogy of the planet.

6. India Rolls out its First Indigenous LCA - Tejas

Tejas, India's first indigenous Light Combat Aircraft (LCA), which is all set to replace the MiG-21 series, has been developed by the Defence Research and Development Organization (DRDO) with Hindustan Aeronautics Limited (HAL) as its principal partner.

Tejas is the smallest, light weight, single engine, single seat, supersonic, multirole, combat

aircraft, and best in its class in the world. It has many features of stealth fighter aircraft. It will be used by both the Indian Air Force (IAF) and the Navy.

This fourth generation combat aircraft has Carbon Composites, light weight/high strength material for primary structures, quadruplex Digital Flight Control System; glass Cockpit and digital Avionics to give multirole capabilities with carefree manoeuvring. These capabilities are further raised by several on-board Sensors, Communication and Navigation Systems that are supported by powerful Mission Computers and Cockpit Display System.

This is for the first time an indigenously designed and developed military fighter aircraft has been certified for Indian Air Force.

Stealth aircraft are designed to avoid detection using a variety of advanced technologies that reduce reflection/emission of radar, infrared, visible light, Radio-Frequency (RF) spectrum, and audio, collectively.

Features of stealth fighter aircraft

- ***The aircraft has a totally digital fly-by-wire control system; the wings are made entirely of composite structures.***
- ***Built by unstable configuration' technique. It has open architecture software for avionics. DRDO can update it as and when required.***
- ***It integrates a 'glass cockpit' in which information is displayed 'real-time' to the pilot.***

7. Cyber Coalition 2013: NATO's Largest-ever Cyber-security Exercise

The North Atlantic Treaty Organization (NATO) has started its largest-ever cyber security exercises to practice thwarting large and simultaneous attacks on member states and their partners. The drill was hosted by National Defence College training centre in Tartu, Estonia.

Codenamed Cyber Coalition 2013, the exercises involve participants from more than 30 countries across Europe, including five non-NATO nations: Austria, Finland, Ireland, Sweden, and Switzerland. New Zealand and the European Union have the observer status.

The exercises are aimed at training technical personnel and their leadership as well as testing the capability of NATO and its partners to coordinate their efforts in foiling multiple simulated cyber attacks.

About Cyber Defence Exercises

- Objective: Cyber defence exercise allows its participants to learn and test the skills needed to fend off a real attack.
- First exercise: 2008, a joint between Swedish and Estonian universities.
- Second Exercise: Baltic Cyber Shield (2010), organised by Swedish National Defence College (SNDC), various Swedish institutions and the Estonian Cyber Defence League.
- Since 2012, the exercise series is called Locked Shields.

8. World's First Nanotube Computer Unveiled

A group of Stanford researchers led by Professor Subhasish Mitra had successfully built a working computer albeit an extremely simple one entirely from transistors fashioned from carbon nanotubes. The nanotubes have long held the promise of allowing smaller, faster and lower-powered computing, though they have proved difficult to work with.

The computer can right now perform only basic functions at speeds likened to a 1950s computer, but the tiny machine was hailed as a breakthrough in the search for an alternative to silicon transistors. Carbon nanotubes (CNTs) are rolled-up, single-layer sheets of carbon atoms tens of thousands can fit into the width of a single human hair. They are pliable and have the highest strength-to-weight ratio of any known material. Silicon is a good semiconductor but cannot be reduced to such a thin layer. Experts believe the structure of CNTs may make them better at carrying currents thus yielding transistors that are faster, more energy efficient and smaller than silicon.

The computer is just a few square millimetres in size and able to perform basic counting and number-sorting functions using 178 transistors

each holding between 10 and 200 nanotubes. It runs at 1 kilohertz—a processing capacity millions of times weaker than today's computers. The 178-transistor limit was due to the team using a university chip-making facility rather than an industrial process, meaning the computer could in theory be made much bigger and faster. The machine ran a basic operating system that allowed it to multitask and swap between the two processes.

Mitra and his team had been able to deal with two inherent shortcomings of CNT transistors: the tubes do not always grow in perfectly straight lines, which mean that mispositioned ones can cause a short circuit, while others changed form and could not be switched on and off. The team devised a method to burn up and eliminate the uncontrolled CNTs in a transistor and to bypass mispositioned ones.

9. MERS VIRUS

MERS-CoV (Middle East Respiratory Syndrome Coronavirus), previously known as the Novel Coronavirus or SARS-like virus, is a member of the coronavirus family.

Coronaviruses commonly cause respiratory illness in mammals, including humans. Coronaviruses are responsible for approximately 1 in every 3 cases of the common cold. MERS-CoV is much more deadly than any other coronavirus seen before.

MERS-CoV is a new coronavirus strain that appeared last year. It started making people ill in the Middle East in 2012 and was first identified when a man in Saudi Arabia came down with "SARS-like" symptoms. He died in June 2012.

Symptoms

Coronaviruses cause respiratory infections in humans and animals. Patients have been presented with fever, cough and breathing difficulties.

It causes pneumonia and, sometimes, kidney failure. Most of the people who have been infected so far have been older men, often with other medical conditions.

What are the treatment options for MERS-CoV infection?

According to the US Centers for Disease Control and Prevention (CDC) and WHO (World Health Organization), there are no specific treatments for patients who become ill with MERS-CoV infection.

All what doctors can currently do is provide supportive medical care to help relieve the symptoms. Supportive cares means providing treatment to prevent, control or relieve complications and side effects, as well as attempting to improve the patient's comfort and quality of life. Supportive care (supportive therapy) does not include treating or improving the illness/condition.

10. Fixed Dose Drug Combinations

A combination drug most commonly refers to a fixed-dose combination (FDC), which is a formulation including two or more active pharmaceutical ingredients (APIs) combined in a single dosage form, which is manufactured and distributed in certain respective fixed doses.

Advantages-

- Simpler dosage schedule improves compliance and therefore improves treatment outcomes.
- Reduces inadvertent medication errors.
- Allows for syngergistic combinations.
- Eliminates drug shortages by simplifying drug storage and handling, and thus lowers risk of being "out of stock".
- Procurement, management and handling of drugs is simplified.
- Side effects are reduced by using one drug of the combination for this purpose.
- Potential for drug abuse can be minimized by using one drug of the combination for this purpose.

Disadvantages-

- FDCs are (possibly) more expensive than separate tablets.
- Potential quality problems, especially with rifampicin in FDCs for TB, requiring bio-availability testing.
- Dosing is inflexible and cannot be regulated to patient's needs (each patient has unique characteristics such as weight,

age, pharmacogenetics, co-morbidity, that may alter drug metabolism and effect).

- Drug interactions may lead to alteration of the therapeutic effect.

11. Umpire Decision Review System

The Umpire Decision Review System is a technology-based system used in the sport of cricket. The system was first introduced in Test cricket, for the sole purpose of reviewing controversial decisions made by the on-field umpires in the case of a batsman being dismissed or not.

There are basically three components in UDRS.

- Hawk-Eye, Eagle Eye, or Virtual Eye: ball-tracking technology that plots the trajectory of a bowling delivery that has been interrupted by the batsman, often by the pad, and can determine whether it would have hit the wicket or not.
- Hot Spot: Infra-red imaging system that illuminates where the ball has been in contact with bat or pad.
- Snickometer, which relies on directional microphones to detect small sounds made as the ball hits the bat or pad, however is no longer used.

12. Digital Signature

A digital signature is a mathematical scheme for demonstrating the authenticity of a digital message or document. A valid digital signature gives a recipient reason to believe that the message was created by a known sender, such that the sender cannot deny having sent the message (authentication and non-repudiation) and that the message was not altered in transit (integrity). Digital signatures are commonly used for software distribution, financial transactions, and in other cases where it is important to detect forgery or tampering.

Digital signatures can be used to authenticate the source of messages. When ownership of a digital signature secret key is bound to a specific user, a valid signature shows that the message was sent by that user.

A Digital Signature Certificate explicitly associates the identity of an individual / device with a pair of electronic keys - public and private keys - and this association is endorsed by the CA. The certificate contains information about a user's identity (for example, their name, pincode, country, email address, the date the certificate was issued and the name of the Certifying Authority that issued it).

These keys complement each other in that one does not function in the absence of the other. They are used by browsers and servers to encrypt and decrypt information regarding the identity of the certificate user during information exchange processes. The private key is stored on the user's computer hard disk or on an external device such as a token. The user retains control of the private key; it can only be used with the issued password.

The public key is disseminated with the encrypted information. The authentication process fails if either one of these keys in not available or do not match. This means that the encrypted data cannot be decrypted and therefore, is inaccessible to unauthorized parties.

13. 3D Printing Technology

Additive manufacturing or 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 also considered distinct from traditional machining techniques, which mostly rely on the removal of material by methods such as cutting or drilling.

Advantages-

- Manufacture of Customized Products.
- Rapid Prototyping.
- Low cost of production.

Disadvantages-

- Manufacture of Dangerous Items
- Issues of counterfeiting.
- Issues of intellectual property rights.

3D printing applications

One of the most important applications of 3D printing is in the medical industry. With 3D printing, surgeons can produce mockups of parts

of their patient's body which needs to be operated upon.

3D printing makes it possible to make a part from scratch in just hours. It allows designers and developers to go from flat screen to exact part.

Nowadays almost everything from aerospace components to toys are getting built with the help of 3D printers. 3D printing is also used for jewellery, architecture, fashion designing, art, and interior designs.

What is the difference between a basic rapid prototyping machine and a 3D printer?

3D printers are the simple version of rapid prototyping machines.

Rapid prototyping is a conventional method that has been used by automotive and aircraft industries for years.

In general 3D printers are compact and smaller than RP machines. They are ideal for use in offices. They use less energy and take less space. They are designed for low volume reproduction of real objects made of nylon or other plastics. That also means 3D printers make smaller parts. Rapid prototyping machines have build chambers at least 10 inches on a side, a 3D printer has less than 8 inches on a side. However, a 3D printer is capable of all the functions of rapid prototyping machine such as verifying and validating design, creating prototype, remote sharing of information, etc.

Consequently 3D printers are easy to handle and cheap to maintain. You can buy one of those DIY kit in the market and build up yourself. It is cheaper than the professional rapid prototyping, for $1000 or less you can have one 3D printer, while the professional rapid prototyping cost at least $50,000.

3D printers are less accurate than rapid prototyping machines. Because of its simplicity the material choices are also limited.

14. FRP Composite Material

Fibre-reinforced plastic (FRP) (also fibre-reinforced polymer) is a composite material made of a polymer matrix reinforced with fibres. The fibres are usually glass, carbon, basalt or aramid, although other fibres such as paper or wood or asbestos have been sometimes used. FRP has the following properties-

- Light weight
- High strength-to-weight ratio
- Corrosion resistance
- Weather resistance
- Low thermal conductivity
- Non-magnetic

Applications of FRP Composites in Construction

Fibre-reinforced plastics are best suited for any design programme that demands weight savings, precision engineering, finite tolerances, and the simplification of parts in both production and operation. A moulded polymer artefact is cheaper, faster, and easier to manufacture than cast aluminium or steel artefact, and maintains similar and sometimes better tolerances and material strengths

There are three broad divisions into which applications of FRP in civil engineering can be classified: applications for new construction, repair and rehabilitation applications, and architectural applications.

FRPs have been used widely by civil engineers in the design of new construction. Structures such as bridges and columns built completely out of FRP composites have demonstrated exceptional durability, and effective resistance to effects of environmental exposure. Pre-stressing tendons, reinforcing bars, grid reinforcement and dowels are all examples of the many diverse applications of FRP in new structures.

One of the most common uses for FRP involves the repair and rehabilitation of damaged or deteriorating structures. Several companies across the world are beginning to wrap damaged bridge piers to prevent collapse and steel-reinforced columns to improve the structural integrity and to prevent buckling of the reinforcement.

Architects have also discovered the many applications for which FRP can be used. These include structures such as siding/cladding, roofing, flooring and partitions.

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Sample Questions
(Science & Technology)

CHRONICLE IAS ACADEMY
A CIVIL SERVICES CHRONICLE INITIATIVE

1. Native resolution is the resolution at which a TV or monitor is designed to display images. 720p and 1080i are the two main standards for broadcasting HDTV signals.

   I. The "i" in 1080i means it presents fast-moving action much more clearly.

   II. The "p" in 720p means fewer video frames per second, thus it doesn't handle fast-moving video.

   Which of the above statements is/are correct?

   (a) I only (b) II only

   (c) Both (d) None

2. Match the following

Lunar Missions	Country
A. SMART-1	I. Japan
B. Luna 2	II. USA
C. Hiten	III. European Space Agency
D. GRAIL	IV. Soviet Union

   Codes:

   (a) A-III; B-II; C-I; D-IV

   (b) A-III; B-IV; C-I; D-II

   (c) A-IV; B-II; C-III; D-I

   (d) A-IV; B-II; C-I; D-III

3. Internet Protocol version 6 (IPv6) is a suite of standard network layer protocols for the Internet. The salient characteristics of IPV6 are:

   I. IPv6 has 132-bit (16-byte) source and destination addresses.

   II. It provides better support for QoS.

   III. It provides an in-built security and promotes interoperability between different IPv6 implementations.

   Which of the above statements is/are correct?

   (a) I only (b) I and II

   (c) II and III (d) All

4. Project Glass - a smart pair of glasses with an integrated heads-up display revealed by Google is a:

   I. Prototype for an "augmented reality" headset that would have the capabilities of a smartphone and more.

   II. It will include a camera, GPS functionality, and Internet connectivity, and voice-activation software.

   III. The operating system software used in the glasses will be Symbian OS.

   IV. Google Glasses will also use voice input and output.

   Which of the above statements is/are correct?

   (a) I and II (b) I, II and IV

   (c) II, III and IV (d) I only

5. Read the following statements related to pulsar stars.

   I. A pulsar is a highly magnetized, rotating neutron star that emits a beam of electro-magnetic radiation.

   II. These are very dense stars composed almost entirely of neutrons and have a diameter of only 20 km (12 miles) or less.

   III. It emit only at X-ray or gamma-ray wavelengths.

   Which of the above statements is/are correct?

   (a) Only I and II

   (b) Only II

   (c) Only I and III

   (d) All of these

6. India's Atomic Energy Regulatory Board (AERB) has become the member of the Multinational Design Evaluation Program (MDEP). Read the following statements related to MDEP and choose the correct answer from the codes given below.

I. MDEP is a program through which national regulators share technical data and standardize regulations and practices in order to avoid duplication of work and review new nuclear power reactor designs.

II. Participating nations are Canada, China, France, Russia, the UK and the USA only.

III. All licensing and regulatory decisions are taken by MDEP and national regulators are bonded by the order.

Codes:

(a) I only

(b) II and III

(c) I and III

(d) I and II

7. Ultrasound waves or ultrasonic waves are the terms used to describe elastic waves with frequency greater than 20,000 Hz. Read the following statements related to ultrasound waves.

I. It propagates through the medium (liquid and gaseous only) in a finite time as a mechanical sound wave by the vibrations of molecules, atoms or any particles present.

II. The speed of propagation depends upon their frequencies.

III. They cannot be transmitted over long distance as loss of energy is very high.

Which of the above statements correctly defines the characteristics of ultrasound waves?

(a) I only

(b) II only

(c) II and III

(d) I and III

8. Lithium-ion batteries are nowadays very popular in iPods, laptops, cellphones. The advantages of Lithium-ion batteries over other batteries are:

I. The rate of self-discharge is much lower than that of other rechargeable cells such as Ni-Cad and NiMH forms.

II. Memory effect" is almost nil in Lithium-ion batteries.

III. The energy density is very high as compared to other batteries.

Which of the above statements are incorrect?

(a) Only I

(b) Only I and III

(c) Only II and III

(d) None of the above

9. What is Surface Computing?

(a) Surface computing is the ability to use computing capability without a pre-defined location and/or connection to a network to publish and/or subscribe to information.

(b) Surface computing allows people to interact with content and information by using their hands and natural movements.

(c) Surface computing is a practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server.

(d) Surface computing is term used in computer science to refer the problem in computer science whose solution is not predictable, uncertain and between 0 and 1.

10. Thirty Meter Telescope (TMT) is a planned ground-based large segmented mirror reflecting telescope, which will enable astronomers to study objects in our own solar system and stars throughout our Milky Way and its neighboring galaxies, and forming galaxies at the very edge of the observable Universe. The board of directors of the TMT Observatory Corporation has selected which of the following as the preferred site for the Thirty Meter Telescope?

(a) Cerro Armazones in Chile

(b) Mauna Kea in Hawai'i

(c) San Pedro Mártir, Mexico

(d) Cerro Tolar, Chile

11. Indo-French space cooperation is all set to soar to new heights with the scheduled launch of a satellite to study changes in the environment. Consider these statements regarding SARAL and identify incorrect statement/s;

I. The SARAL-Altika satellite, a joint project of the space agencies of India and France, will complement the observations of the seas made by current satellites.

II. India's rocket, Polar Satellite Launch Vehicle (PSLV) will put the 450 kg Indo-French satellite into orbit from its spaceport at Sriharikota.

III. SARAL is short for Satellite with ARgos and ALtiKa, the two main devices on it which have been provided by ISRO. Besides building the spacecraft, French space agency CNES will launch and operate it through its life.

IV. AltiKa is a Ka-band altimeter system, dedicated to accurate measurement of the rise in the sea levels.

Codes:

(a) Only II and III

(b) Only II and IV

(c) Only III

(d) Only IV

12. Consider the following statements

I. Nishant is an Unmanned Aerial Vehicle-(UAV) developed by ADE (Aeronautical Development Establishment) of the DRDO.

II. Rustom is a lightweight multirole fighter aircraft developed by DRDO.

III. Tejas is a Medium Altitude Long Endurance unmanned combat air vehicle (UCAV) being developed by DRDO.

IV. Ulka is an air-launched expendable target drone developed by DRDO.

Which of these statements are true?

(a) I and III only

(b) I, II and III

(c) I and IV only

(d) II, III and IV

13. Shale gas is natural gas formed from being trapped within shale formations. Shale gas has become an increasingly important source of natural gas since the start of this century. Which among these statements regarding Shale gas are true?

I. Production of shale gas increased considerably after technological advances in directional and horizontal drilling, microseismic imaging, and hydraulic fracturing

II. The greenhouse effect of Shale gas is minimal when compared to other petroleum resources, thus making it a clean source of energy

III. Shale gas is believed to change the energy dynamics of the world as it will reduce the dependence on the middle eastern petroleum resources

(a) I only (b) II only

(c) I and III (d) II and III

14. A quantum dot display is a type of display technology used in flat panel displays as an electronic visual display. Quantum dots (QD) or semiconductor nanocrystals are a form of light emitting technology and consist of nano-scale crystals that can provide an alternative for applications such as display technology. Which of the statements about QD displays are true?

I. Quantum dot displays are able to yield a greater portion of the visible spectrum than current technologies, thus enlarging the colour range of the display

II. Quantum dot displays use 30 to 50% less electrical power than an LCD, in large part because nanocrystal displays don't need a backlight

III. Compared to LCD and OLED, the manufacturing cost of QD-LED is relatively low and development of novel and even more cost-efficient fabrication process is possible, effectively bringing the cost even lower

(a) I and II

(b) II and III

(c) I and III

(d) All of the above

15. Consider the following statements and select the correct answer?

I. Black silicon is a semiconductor material, with very low reflectivity and high absorption of visible light.

II. Black silicon is produced by irradiating standard silicon with femtosecond laser pulses under a sulfur containing atmosphere.

III. Black silicon solar cells can absorb nearly all of the sunlight that hits them, including infrared radiation, and produce twice the electricity of regular solar panels.

Codes:

(a) I, II, only (b) II, III, only

(c) I, III only (d) All

16. A quantum computer is a computation device that uses quantum mechanical phenomena, such as superposition and entanglement, to perform operations on data. Quantum computers require data to be encoded in form of

(a) bits (b) qubits

(c) 0 or 1 (d) Both (a) & (c)

17. Open source software (OSS) is computer software with its source code made available and licensed with an open source license in which the copyright holder provides the rights to study, change and distribute the software to anyone and for any purpose. Which among the following statements regarding open source software are true?

I. GNU/Linux, Mozilla Firefox, Apache HTTP Server, Android etc. are examples of open source software

II. In general, open source software is compact, and as a result requires less hardware power to accomplish the same tasks as compared to closed/proprietary software, thus bringing down the cost of hardware power required.

Codes:

(a) I only (b) II only

(c) Both of the above (d) None of the above

18. In the context of recent outbreaks of Swine flu consider the following statements and select the correct answer?

I. Swine influenza, also called, swine flu, hog flu and pig flu, is a respiratory disease, caused by a strain of the influenza type A virus known as H1N1.

II. Symptoms of Swine flu include fever, cough, sore throat, body aches, headache, chills and fatigue.

III. Swine influenza A (H1N1) virus has components of pig and bird influenza viruses thus the transmission of the virus from pigs to humans is most common and always leads to human flu.

Codes:

(a) I, II only (b) II, III only

(c) I, III only (d) All

19. Which of these statements about Integrated chips are

I. An integrated circuit (IC) an entire electrical circuit with numerous transistors, wires, and other electrical devices all built into a single square of semiconductor such as silicon, germanium, antimony, etc.

II. Wafer-scale integration (WSI) is a system of building very-large integrated circuits that uses an entire silicon wafer to produce a single "super-chip".

III. The cost of ICs over discrete circuits are low because the chips, with all their components, are printed as a unit by photolithography rather than being constructed one transistor at a time.

(a) Only 1 & 3 are correct

(b) Only 2 & 3 are correct

(c) Only 1 & 2 are correct

(d) All are correct

20. Brain Fingerprinting is a forensic science technique to determine whether specific information is stored in a subject's brain. Which among the following statements are true regarding Brain Fingerprinting?

I. It does this by measuring electrical brainwave responses to words, phrases, or pictures that are presented on a computer screen.

II. The technique of Brain Fingerprinting is controversial, because some people consider it unethical and invasive to electrically probe human thoughts and feelings.

(a) I only (b) II only

(c) Bothe of the above

(d) None of the above

21. Research into the health benefits of foods has been escalating during the last five to seven years, driven by consumers aware of the relationship of diet to optimal health, ever-increasing health care costs and others motivated to take control of their own health. Which of the following are correctly matched?

I. Nutraceutical - a food or food product that reportedly provides health and medical benefits, including the prevention and treatment of disease.

II. Functional foods - are enriched with vitamins and minerals, usually at a range up to 100 percent of the Dietary Reference

Intake, formally called the Recommended Daily Allowance for that nutrient.

III. Fortified foods - any product (other than tobacco) that is intended to supplement the diet and contains vitamin, mineral, herb or other botanical; an amino acid or metabolite; an extract; or any combination of the mentioned items.

Codes:

(a) Only I (b) Only II

(c) Only III (d) All of the above

22. Bio-engineering researchers from Stanford University have developed the first biological Internet or 'Bi-Fi'. Read the following statements regarding Bi-Fi:

I. The technology uses an innocuous bacterium called M13 to increase the complexity and amount of information that can be sent from cell to cell.

II. M13 reproduces within its host, takes strands of DNA -- strands that engineers can control -- wrap them up one by one and send them out encapsulated within proteins produced by M13 that can infect other cells.

Which of the above statements are true?

(a) I only (b) II only

(c) Both I and II (d) Neither I nor II

23. Heavy water is a form of water that contains a larger than normal amount of the hydrogen isotope deuterium rather than the common hydrogen-1 isotope that makes up most of the hydrogen in normal water. Heavy water is used in nuclear reactors. Read the following statements about the heavy water:

I. Heavy water has molecular weight of 18amu.

II. The density of heavy water is lower than normal water.

III. Heavy water is usually radioactive.

Which of the above statements are true?

(a) I and II (b) II and III

(c) All of the above (d) None of the above

24. Consider the following statement about the recently launched Science, Technology and Innovation Policy (STI) 2013 and select the correct answer?

I. One of the main aims of policy is to promoting the spread of scientific temper among the youth.

II. A Strong and viable Science, Research and Innovation system for High Technology led path for India (SRISHTI) are the goal for the STI policy.

III. New policy seeks to raise the Gross Expenditure in Research and Development (GERD) to 2% from the present 1% of the GDP in this decade by encouraging enhanced private sector contribution.

Codes:

(a) I, II only (b) II, III only

(c) I, III only (d) All

25. Which among the following is/ are produced by the Council of Scientific & Industrial Research (CSIR)?

I. 'Risorine'- indigenously drug formulation against tuberculosis.

II. First indigenous Wankel Engine powered unmanned Air Vehicle 'NISHANT'.

III. 'Diastep' - shelf footwear for low risk diabetic patients.

Codes:

(a) I, II only (b) II, III only

(c) I, III only (d) All

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SCIENCE & TECHNOLOGY
SAMPLE QUESTIONS
(ANSWERS)

CHRONICLE
IAS ACADEMY
A CIVIL SERVICES CHRONICLE INITIATIVE

1. (d)
2. (b)
3. (d)
4. (b)
5. (a)
6. (a)
7. (b)
8. (d)
9. (b)
10. (b)
11. (c)
12. (c)
13. (c)
14. (a)
15. (d)
16 (b)
17. (c)
18. (a)
19. (b)
20. (c)
21. (a)
22. (b)
23. (d)
24. (b)
25. (d)

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UPSC Questions

(Science & Technology)

CHRONICLE IAS ACADEMY
A CIVIL SERVICES CHRONICLE INITIATIVE

1. Recombinant DNA technology (Genetic Engineering) allows genes to be transferred.
   1. across different species of plants.
   2. from animals to plants.
   3. from microorganisms to higher organisms.

   Select the correct answer using the codes given below.

   (a) 1 only (b) 2 and 3 only
   (c) 1 and 3 only (d) 1, 2 and 3

2. Which of the following can be found as pollutants in the drinking water in some parts of India?
   1. Arsenic 2. Sorbitol
   3. Fluoride 4. Formaldehyde
   5. Uranium

   Select the correct answer using the codes given below.

   (a) 1 and 3 only (b) 2, 4 and 5 only
   (c) 1, 3 and 5 only (d) 1, 2, 3, 4 and 5

3. With reference to the usefulness of the by-products of sugar industry, which of the following statements is/are correct?
   1. Bagasse can be used as biomass fuel for the generation of energy.
   2. Molasses can be used as one of the feedstocks for the production of synthetic chemical fertilizers.
   3. Molasses can be used for the production of ethanol.

   Select the correct answer using the codes given below.

   (a) 1 only (b) 2 and 3 only
   (c) 1 and 3 only (d) 1, 2 and 3

4. Due to improper/indiscriminate disposal of old and used computers or their parts, which of the following are released into the environment as e-waste?
   1. Beryllium 2. Cadmium
   3. Chromium 4. Heptachlor
   5. Mercury 6. Lead
   7. Plutonium

   Select the correct answer using the codes given below.

   (a) 1, 3, 4, 6 and 7 only
   (b) 1, 2, 3, 5 and 6 only
   (c) 2, 4, 5 and 7 only
   (d) 1, 2, 3, 4, 5, 6 and 7

5. The efforts to detect the existence of Higgs boson particle have become frequent news in the recent past. What is /are the importance/importances of discovering this particle?
   1. It will enable us to understand as to why elementary particles have mass.
   2. It will enables us in the near future to develope the technology to transferring matter from one point to another without traversing the physical space between them.
   3. It will enable us to create better fuels for nuclear fission.

   Select the correct answer using the codes given below:

   (a) 1 only
   (b) 2 and 3 only
   (c) 1 and 3 only
   (d) 1, 2 and 3

6. Mycorrhizal biotechnology has been used in rehabilitating degraded sites because mycorrhiza enables the plants to.
   1. resist drought and increase absorptive area
   2. tolerate extremes of PH
   3. Resist disease infestation

   Select the correct answer using the codes given below:

   (a) 1 only
   (b) 2 and 3 only
   (c) 1 and 3 only
   (d) 1, 2 and 3

7. Consider the following statements:

If there were no phenomenon of capillarity

1. It would be difficult to use a kerosene lamp.
2. One would not be able to use a straw to consume a soft drink.
3. The blotting paper would fail to function.
4. The big trees that we see around would not have grown on the Earth.

Which of the statements given above are correct?

(a) 1, 2 and 3 only (b) 1, 3 and 4 only
(c) 2 and 4 only (d) 1, 2, 3 and 4

8. Consider the following kinds of organisms:

1. Bacteria
2. Fungi
3. Flowering plants

Some species of which of the above kinds of organisms are employed as biopesticides?

(a) 1 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

9. Biomass gasification is considered to be one of the sustainable solutions to the power crisis in India. In this context, which of the following statement is/are correct?

1. Coconut shells, groundnut shells and rice husk can be used in biomass gasification.
2. The combustible gases generated from biomass gasification consist of hydrogen and carbon dioxide only.
3. The combustible gases generated from biomass gasification can be used for direct heat generation but not in internal combustion engines.

Select the correct answer using the codes given below:

(a) 1 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

10. What is the role of ultraviolet (UV) radiation in the water purification systems?

1. It inactivates/kills the harmful micro-organisms in water.
2. It removes all the undesirable odours from water.
3. It quickens the sedimentation of solid particles, removes turbidity and improves the clarity of water.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

11. Graphene is frequently in news recently. What is its importance?

1. It is a two-dimensional material and has good electrical conductivity.
2. It is one of the thinnest but strongest materials tested so far.
3. It is entirely made of silicon and has high optical transparency.
4. It can be used as 'conducting electrodes' required for touch screens, LCDs and organic LEDs.

Which of the statements given above are correct?

(a) 1 and 2 only (b) 3 and 4 only
(c) 1, 2 and 4 only (d) 1, 2, 3 and 4

12. With reference to 'stem cells', frequently in the news, which of the following statements is/are correct?

1. Stem cells can be derived from mammals only.
2. Stem cells can be used for screening new drugs.
3. Stem cells can be used for medical therapies.

Select the correct answer using the codes given below:

(a) 1 and 2 only (b) 2 and 3 only
(c) 3 only (d) 1, 2 and 3

13. A team of scientists at Brookhaven National Laboratory including those from India created the heaviest anti-matter (anti-helium nucleus). What is/are the implication/implications of the creation of anti-matter?

1. It will make mineral prospecting and oil exploration easier and cheaper.
2. It will help probe the possibility of the existence of stars and galaxies made of anti-matter.
3. It will help understand the evolution of the universe.

Select the correct answer using the codes given below:

(a) 1 only (b) 2 and 3 only
(c) 3 only (d) 1, 2 and 3

14. Which of the following is/are cited by the scientists as evidence/evidences for the continued expansion of universe?

1. Detection of microwaves in space.
2. Observation of redshift phenomenon in space.
3. Movement of asteroids in space.
4. Occurrence of supernova explosions in space.

Select the correct answer using the codes given below:

(a) 1 and 2
(b) 2 only
(c) 1, 3 and 4
(d) None of the above can be cited as evidence

15. Electrically charged particles from space travelling at speeds of several hundred km/sec can severely harm living beings if they reach the surface of the Earth. What prevents them from reaching the surface of the Earth?

(a) The Earth's magnetic field diverts them towards its poles.
(b) Ozone layer around the Earth reflects them back to outer space.
(c) Moisture in the upper layers of atmosphere prevents them from reaching the surface of the Earth.
(d) None of the statements (a), (b) and (c) given above is correct.

16. To meet its rapidly growing energy demand, some opine that India should pursue research and development on thorium as the future fuel of nuclear energy. In this context, what advantage does thorium hold over uranium?

1. Thorium is far more abundant in nature than uranium.
2. On the basis of per unit mass of mined mineral, thorium can generate more energy compared to natural uranium.
3. Thorium produces less harmful waste compared to uranium.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2, and 3

17. What are the reasons for the people's resistance to the introduction of Bt brinjal in India?

1. Bt brinjal has been created by inserting a gene from a soil fungus into its genome.
2. The seeds of Bt brinjal are terminator seeds and therefore, the farmers have to buy the seeds before every season from the seed companies.
3. There is an apprehension that the consumption of Bt brinjal may have adverse impact on health.
4. There is some concern that the introduction of Bt brinjal may have adverse effect on the biodiversity.

Select the correct answer using the codes given below:

(a) 1, 2 and 3 only (b) 2 and 3 only
(c) 3 and 4 only (d) 1, 2, 3 and 4

18. Other than resistance to pests, what are the prospects for which genetically engineered plants have been created?

1. To enable them to withstand drought.
2. To increase the nutritive value of the produce.
3. To enable them to grow and do photosynthesis in spaceships and space stations.
4. To increase their shelf life.

Select the correct answer using the codes given below:

(a) 1 and 2 only (b) 3 and 4 only
(c) 1, 2 and 4 only (d) 1, 2, 3 and 4

19. Satellites used for telecommunication relay are kept in a geostationary orbit. A satellite is said to be in such an orbit when:

1. The orbit is geosynchronous.
2. The orbit is circular.
3. The orbit lies in the plane of the Earth's equator.
4. The orbit is at an altitude of 22,236 km.

Select the correct answer using the codes given below:

(a) 1, 2 and 3 only (b) 1, 3 and 4 only
(c) 2 and 4 Only (d) 1, 2, 3 and 4

20. At present, scientists can determine the arrangement or relative positions of genes or DNA sequences on a chromosome. How does this knowledge benefit us?

1. It is possible to know the pedigree of livestock.
2. It is possible to understand the causes of all human diseases.
3. It is possible to develop disease-resistant animal breeds.

Which of the statements given above is/are correct?

(a) 1 and 2 only (b) 2 Only
(c) 1 and 3 only (d) 1, 2 and 3

21. Microbial fuel cells are considered a source of sustainable energy. Why?

1. They use living organisms as catalysts to generate electricity from certain substrates.
2. They use a variety of inorganic materials as substrates.
3. They can be installed in waste water treatment plants to cleanse water and produce electricity.

Which of the Statements given above is/are correct?

(a) 1 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

22. The Function of heavy water in a nuclear reactor is to.

(a) Slow down the speed of neutrons.
(b) Increase the speed of neutrons.
(c) Cool down the reactor.
(d) Stop the nuclear reaction.

23. What is the difference between Bluetooth and Wi-Fi devices?

(a) Bluetooth uses 2-4GHz .radio frequency band, whereas Wi-Fi can use 2-4 GHz or 5GHz frequency band.
(b) Bluetooth is used for Wireless Local Area Networks, (WLAN) only, whereas Wi-Fi is used for Wireless Wide Area Networks (WWAN) only.
(c) When information is transmitted between two devices using Bluetooth technology, the devices have to be in the line of sight of each other, but when Wi-Fi technology is used the devices need not be in the line of sight of each other.
(d) The statemen (a) and (b) given above are correct in this context.

24. What is the difference between a CFL and an LED lamp?

1. To produce light, a CFL uses mercury vapour' and phosphor while an LED lamp uses semiconductor material.
2. The average life span of a CFL is much longer than that of an LED lamp.
3. A CFL is less energy-efficient as compared to an LED lamp.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 and 3 only
(c) l and 3 only (d) 1, 2 and 3

25. A new optical disc format known as the Blu-ray Disc (BD) is becoming popular. In what way is it different from the traditional DVD?

1. DVD supports Standard Definition video while BD supports High Definition video.
2. Compared to a DVD, the BD format has several times more storage capacity.
3. Thickness of BD is 2-4 mm while that of DVD is 1-2 mm.

Which of the statements given above is /are correct?

(a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

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SCIENCE & TECHNOLOGY
UPSC QUESTIONS
(ANSWERS)

CHRONICLE
IAS ACADEMY
A CIVIL SERVICES CHRONICLE INITIATIVE

1. (a)
2. (a)
3. (d)
4. (b)
5. (a)
6. (d)
7. (d)
8. (d)
9. (a)
10. (a)
11. (c)
12. (b)
13. (c)
14. (b)
15. (a)
16 (d)
17. (b)
18. (c)
19. (a)
20. (d)
21. (d)
22. (a)
23. (c)
24. (c)
25. (b)

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