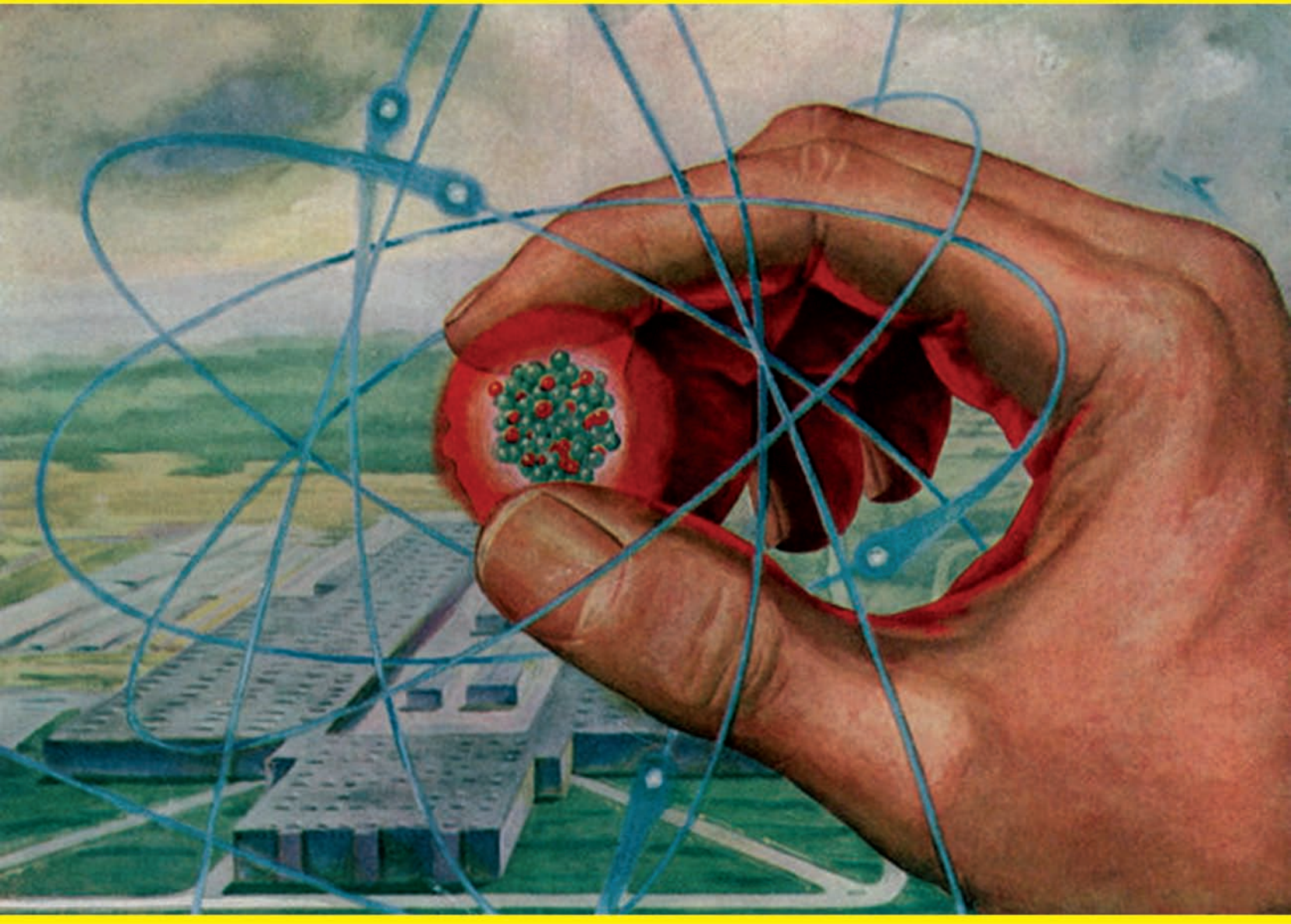
Science Horizon

ODISHA BIGYAN ACADEMY

4TH YEAR 8TH ISSUE AUGUST 2014



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The Secretary, Odisha Bigyan Academy invites articles in English on Basic and Applied Sciences from scientists, technologists and professionals to be published in the English magazine **"SCIENCE HORIZON"**. The articles should be lucid and easily understood by students of Higher Secondary schools, undergraduate students and common readers. They should focus on scientific topics and should be presented in a popular style covering information on scientific discoveries/inventions, biography of scientists, eradication of superstitions, development of scientific temper, story, features, snippets etc. The article should ordinarily be of two to three printed pages in one side of A-4 size paper with attractive headings. The authors are requested to give their E-mail, Contact details, passport size photograph along with Bank Account No. etc. for transfer of remuneration for their published article. The articles should be sent to the Secretary, Odisha Bigyan Academy by the following address by post / in person along with softcopy through E-mail.

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The Cover Page depicts : **Atom for Peace.** ***Cover Design : Sanatan Rout***

EDITORIAL

NUCLEAR TECHNOLOGY WITH 'ATOM FOR PEACE' - INITIATIVE

Every year on 6th and 9th August, history reminds the World Community about the dreadful power of the atom that devastated Hiroshima and Nagasaki of Japan on these days in 1945 during the last phase of Second World War. As an aftermath awakening on this shameful act of self-destruction of humanity, the International Nuclear Community started the 'Atom for Peace' - initiative to develop appropriate Nuclear Technology for harnessing power of the atom as a tool for the benefit of mankind.

Majority of people are well aware of the contribution of nuclear technology to the production of electricity via commercial nuclear power plants. But most people are quite unaware about the greater impact of this technology through non-power applications. There are many other ways, the peaceful atom has entered quietly into our lives, often unannounced and in many cases unappreciated and yet serving us in providing food, clothing, comfort as well as ensuring our health, happiness, safety and security. This has been possible by harnessing the power of the radio-isotopes and the radiations for applications in health care, industry, agriculture and research as well. These new applications continue to make major humanitarian contributions to the quality of our lives. A few such applications out of the myriads of others in practice can be cited here for general awareness and appreciation.

Radiation, mainly gamma radiation in high enough quantities, kills micro-organisms, for which radiation treatment has been the common practice now-a-days to sterilize most of the medical equipments, surgical gloves, dressings, bandages, syringes, catheters, heart valves and other devices routinely used during medical procedures. Radiation being a cold process it also sterilizes a range of heat sensitive items such as powders, ointments, solutions, face-creams and biological preparations like bone, nerve, skin etc. used in tissue grafts. The imaging properties of radio-isotopes have proved superior to X-rays in nuclear diagnostic techniques to determine anomalies in heart, brain, kidneys, lungs, liver, breast and thyroid glands. Bone and joint disorders along with spinal disorders also benefit directly using radio-isotopes in modern imaging techniques such as Single Photon Emission Computed Tomography (SPECT) and Positron Emission Tomography (PET). Therapeutic uses of radio-isotopes and radiations in the treatment of cancer is widely known, which is improving day by day by targeting the cancerous tissue only without killing or impairing the healthy tissues.

In the field of agriculture, specialized radiation techniques have been used to produce superior species of crops and many other mutant varieties called cultivars, which include grains such as rice, barley, wheat, bans lentils and peas; fruit varieties such as apples, oranges, bananas, grapefruit, pomegranates, grapes; crops such as cotton, sunflower, soybeans etc.; ornamental flowers such as roses, dahlias, bougainvilleas etc. Besides that, food irradiation involving carefully controlled amounts of ionizing radiations such as beta particles or gamma rays to break the DNA-bonds of targeted pathogens have improved the shelf-life of many food and agricultural products.

In industrial sectors, radio-active isotopes are used as tracers to study the mixing and flow-rates of wide range of materials, to locate leaks and to measure the rate of wear of engines and plant equipments. As tracers isotopes also play an important part in detecting and analyzing pollutants in the environment. Radio-active emissions are highly penetrative. On the principle of their attenuation property in material medium, level gauges are used in industries where levels of gases, liquids and solids must be checked. Radio-isotope thickness gauges are used in making of continuous sheets of materials such as paper, plastic film, metal and glass sheets etc. Density gauges are also used in detergent manufacture. By appropriate exposure to radiation, changes in molecular structure can be created for new material development. Radiation cross-linked poly-vinyl chloride used for wire and cable insulations, vulcanization of rubber for tyre production, heat-shrink polymers used for packaging, wood-plastic composites cured by gamma radiation used as flooring materials are few such examples. Some materials are also created by altering their molecular structure to absorb huge amounts of liquid. Examples include air-refresheners, tissue papers, sanitary napkins and diapers etc. Finally radiation is also used for public safety, including airport screening, smoke detectors, crime solving, archeology dating etc. Thus the list of applications of radio-isotopes and radiations can literally go on and on which enhance our modern life style that we have taken for granted. During the last fifty or more years the challenge to harness power of atom for humanitarian applications has been very impressively met which is nothing short of a wonder.

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ATOM FOR PEACE, NOT FOR WAR

Prof. Manashi Goswami

Come August, the whole world remembers two frightful days of world history, August 6th and 9th, 1945. The atomic bombings of the cities of Hiroshima and Nagasaki in Japan were conducted on these days by the United States during the final stage of World War II. These two bombings were the first and remain the only use of nuclear weapons in warfare.

By August 1945, the allied Manhattan project had successfully tested an atomic device and had produced weapons based on two alternate designs. A uranium gun type atomic bomb (Little Boy) was dropped on Hiroshima on August 6, 1945, followed by a Plutonium implosion-type bomb (Fat Man) on the city of Nagasaki on August 9. Within the first two to four months of the bombing, acute effect killed 90,000 - 166,000 people in Hiroshima and 60,000 - 80,000 in Nagasaki. During the following months large number of people died various radiation effects and injuries.

On the Day

At 2.45 am on Monday, August 6, 1945 a B -29 bomber plane, the Enola Gay took off from Tinian, a north pacific island in the Marinianas, 1500 miles south of Japan. Colonel Paul Tibbets, the pilot nick named B-29 as "Enola Gay" after his mother. Just before the take-off the plane's nick name was painted on its sides. The Enola Gay was escorted by two other bombers that carried cameras and a variety of measuring instruments. Three other planes had left earlier in order to ascertain the weather condition over the possible targets. On the hook in the ceiling of the plane hung the ten- foot atomic bomb "Little Boy". On 6th August, 1945, the first choice target Hiroshima, was having clear weather. At 8:15(am) local time, Enola Gay's door sprang open and it dropped the little boy.

The Mushroom Cloud

The bomb exploded 1,900 feet above the city. The mushroom cloud itself was a spectacular sight. A bubbling mass of purple-gray smoke with a hot red burning core estimated to have reached a height of 40,000 feet. Such was the description of dreadful devastation that took place on 6th August 1945 at Hiroshima city.

Why Hiroshima

The U.S.A. began in spring 1945 studying targets for dropping of the atomic bomb. To observe accurately the effect of atomic bombing, the potential cities required to have an urban area of at least 5 km in diameter. On July 25, 1945, an order was issued calling for

the first atomic bomb to be dropped on one of the four cities Hiroshima,Kokura,Niigata & Nagasaki. The name Hiroshima as the prime target was issued on August 2. One reason is that Hiroshima was the only city thought to have no Allied-prisoner-of-war camps. On 6th August, the sky over Hiroshima city was clear hence Hiroshima's fate was destined for destruction.

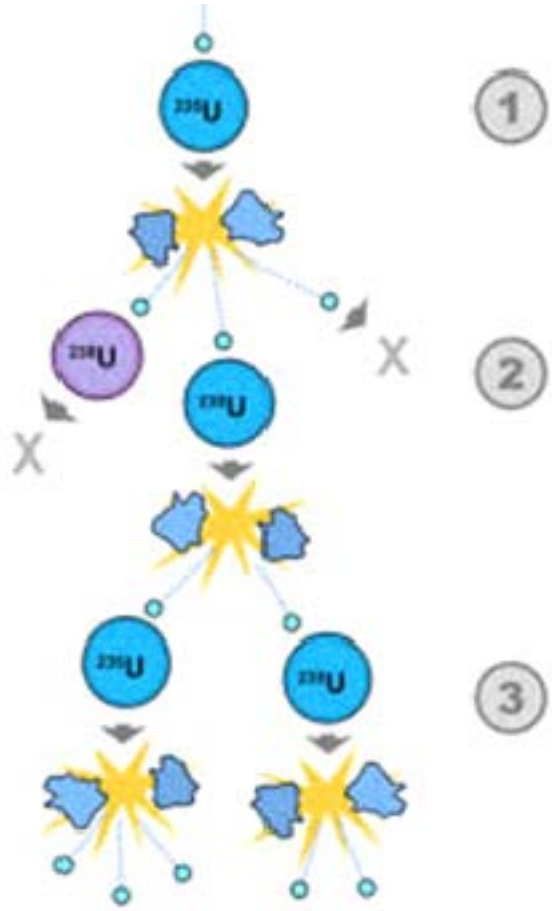
The Science Behind Atom Bomb

A nuclear explosion is an explosion that occurs as a result of the rapid release of energy from high speed nuclear fission or fusion reaction. The driving reaction may be nuclear fission, nuclear fusion or a multistage cascading combination of two.

The immense destructive power of atomic weapons is derived from a sudden release of energy produced by splitting the nuclei of the fissile elements making up the bomb's core. The U.S. developed two types of fission based atomic bombs during the second world war. The first "Little Boy" was a gun type weapon with a uranium core. The second weapon dropped on Nagasaki was called "Fat Man" and was an implosion-type device with a plutonium core.

Fission

The isotopes Uranium- 235 and Plutonium-239 readily undergo fission. Fission occurs when a thermal neutron strikes the nucleus of either isotope splitting the isotopes into fragments and releasing a tremendous amount of energy. For example splitting of one atom of uranium produces around 220 MeV of energy. The fission process becomes self-sustaining as neutrons produced by the splitting of atom strike nearby nuclei and produce more fission. This is known as chain reaction which causes nuclear explosion.



Nuclear Chain Reaction

Natural uranium contains very less amount (0.7%) of fissionable U-235 isotopes and rest is U-238 isotopes. When a uranium-235 atom absorbs a neutron and splits into two new atoms, it releases three new neutrons and the sum total of mass lost in the process appears in the form of energy according to Einstein's famous Mass-Energy equivalence

formula $E = mc^2$. Two neutrons do not continue the chain reaction because they are lost or absorbed by U-238 atom. However, on an average one neutron does collide with a neighbouring atom of U-235, which then splits and releases again neutrons and some energy. This causes a nuclear chain reaction.

Criticality

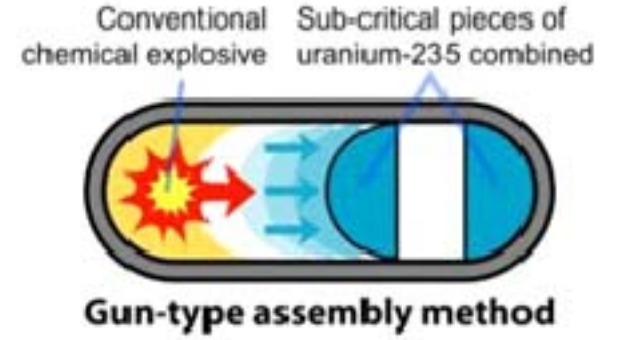
In order to detonate an atomic weapon, a critical mass of fissionable material is needed. This means enough uranium-235 or plutonium-239 is required to ensure that neutrons released by fission will strike another nucleus, thus producing a chain reaction. The more fissionable material is available the more is the chance that such an event will occur. Critical mass is defined as the amount of material at which a neutron produced by a fission process will, on an average create another fission event.

Difference between Little Boy & Fat Man

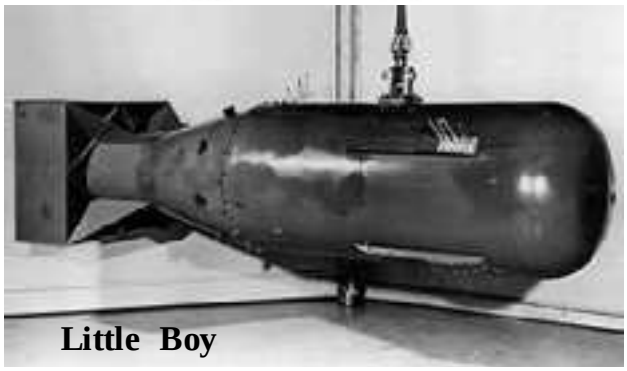
Little Boy and Fat Man utilized different elements and completely separate methods of construction in order to function as nuclear weapons. Little Boy detonated due to a fission chain reaction involving the isotope U-235 of uranium, while Fat Man used Pu-239 isotope of plutonium.

Little Boy

Little Boy was powered by the Uranium isotope U-235. Most Uranium found naturally in the world exist as U-238, leaving only 0.7% of naturally existing Uranium as the U-235 isotope. When a neutron bombards on U-238, the isotope often captures the neutron to become U-239, failing to fission, and thus failing to instigate a chain reaction that would detonate a bomb. Hence the first challenge of the project was to determine the most efficient way to separate and purify U-235 from the overly abundant U-238.



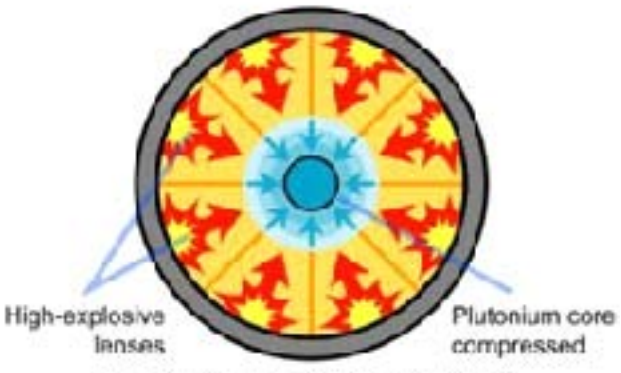
Gun-type assembly method


Little Boy

Once enough Uranium-235 was obtained to power the bomb, the bomb was assembled with a gun type design. In this special design an amount of U-235 is fired at another to combine the two masses. This combination created a critical mass that sets off a fission chain reaction to eventually detonate a bomb. The two masses of U-235 had to combine quickly to avoid the spontaneous decay of the atom which would cause the bomb to fizzle and thus fail to explode. Little Boy was carrying around 64 kg of pure U-235 of which only 0.6 kg was detonated during the explosion.

Fat Man

Powered by Plutonium, Fat Man could not use the same gun-type design that allowed Little Boy to explode effectively. The form of Plutonium collected was containing traces of Pu-240 isotope, as opposed to the desired Pu-239. Pu-240's higher decay rate would cause spontaneous decay before the gun type design could bring two masses of plutonium together. This process lowers the energy involved in the actual detonation of the bomb. Hence, a new design was constructed at Los Alamos laboratory of U.S.A. The new design used conventional explosives around a central Plutonium mass to quickly squeeze and consolidate Plutonium, increasing pressure and density of the substance. An increased density allowed the Plutonium to reach its critical mass, firing neutrons and allowing fission chain reaction to proceed. To detonate the bomb the explosives were ignited, releasing a shock wave that compressed the inner Plutonium core and led to its explosion. Fat Man was carrying 6.2kg of plutonium, of which only 20% was detonated during explosion.



Implosion assembly method


Fat Man

Atom for Peace

It was unfortunate that the atomic energy before being utilized for the benefit of mankind was used for destruction of mankind. In 1950s the attention was shifted to harnessing the power of the atom in a controlled manner to apply the steady heat yield for generating electricity through nuclear reactors. However, by 1942 the first artificial nuclear reactor, Chicago Pile -1 had been already constructed at the University of Chicago by a team led by Enrico Fermi. But the primary purpose of those reactors was the mass production of Plutonium isotopes for nuclear weapons. Besides the military use of nuclear power, there were political reasons to pursue civilian use of atomic energy. U.S.A. president Dwight Eisenhower made his famous ATOM FOR PEACE speech to the UN general assembly on December 8, 1953. This diplomacy led to the dissemination of reactor technology to all institutions worldwide including those in U.S.A.

Before 1950s, radiation from Radium was the only source for treatment of cancer. Now nuclear reactor has opened up possibilities for making other elements radioactive. These

radioactive isotopes are now used extensively in medicine, agriculture and industry. Radioactive isotopes have helped in diagnosis and prevention of many critical diseases. They are of immense use in the field of agriculture for better production of crops, high yielding variety of seeds, pest control and fertilisers. Radiation alternated vaccine has immunised sheep from lungworm diseases. In India under UNDP (United Nation Development Programme) collaboration such vaccines are going to be produced commercially in a laboratory located in Kashmir Valley. Bhabha Atomic Research Centre at Trombay is well known in the world for production of many useful radioisotopes. It produces near about 325 radioisotopes.

Bhabha Atomic Research Centre (Trombay).

Perishable food stuffs, if exposed to radiation, are found to remain fresh beyond their normal time. Hence radiation is used for canning of food and preservation. In a tropical country like India, self- life of fruits and vegetables are short. Small dose of radiation prevents sprouting of potato and onion while higher dose can delay the ripening of mango, apple, banana etc. BARC, Trombay has a semi commercial food processing plant.

At present 30 countries worldwide are operating 435 nuclear reactors providing 12.3% of the world's electricity. The use of nuclear power in domestic and commercial purpose has become a reality in France since 1976. France has been still dominating the world in nuclear power with 73.3% share of its total power consumption. After Kudankulam reactor of India being fully operational with almost

Kudankullan Reactor Centre

1000MW power output, the number of reactors in India has been raised to 21, with nuclear power capacity of 5308 MW and nuclear power share has enhanced to 3.5%. The whole world has now realised that nuclear energy is the ultimate source of energy which can reduce the greenhouse gases and save our earth from global warming, which is pushing it to a big catastrophe. So it is well justified that atom only can bring peace to the world in true sense, if immensely available energy from its core can be judiciously harnessed and utilised for the well being of the entire mankind.

■

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RADIOACTIVE WASTE : A HINDRANCE TO NUCLEAR POWER

Shri Kamala Kanta Jena

Matter is made up of molecules. Molecule is composed of atoms. A water molecule represented by H_2O consists of two Hydrogen atoms and one Oxygen atom. Atoms are so small that a row of one lakh atoms can accommodate within the thickness of a hair. Atom carries protons, neutrons and electrons. Protons and neutrons are concentrated within a tinier nucleus, whereas electron cloud makes up the rest of the atom's overall size. Keeping protons and neutrons within such a squashed space is possible for the strongest *nuclear force*, which is 10^{38} (one followed by 38 zeros) times the gravitational force.

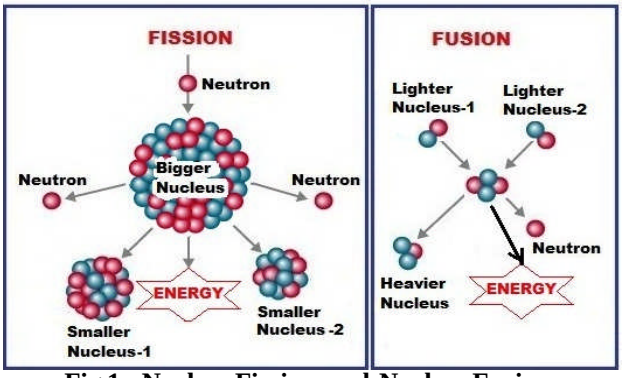

Fig 1 : Nuclear Fission and Nuclear Fusion

A bigger nucleus can split up into smaller nuclei. Splitting up of a bigger nucleus into smaller ones as in case of atom bomb is known as *nuclear fission*. Two or more lighter nuclei can combine to create heavier nucleus. Formation of heavier nucleus due to combination of two or more lighter nuclei as in case of Sun is known as *nuclear fusion*. Huge amount of energy is released in both the processes. The energy so obtained is known as *atomic energy*. Atomic energy is produced by *nuclear reactors* in nuclear power plants. A nuclear reactor is a power-generating device in which heat is derived from a controlled nuclear reaction. The heat is used to convert water into its vapour which rotates turbine that produces electricity. We deal with fission reactors to extract heat in power stations. Electricity generated by nuclear power constitutes 75% of the total power generated in France, 50% in Switzerland, 30% in Germany, 20% in the United States and only 3% in India.

Radioactive Nuclear Waste

Thermal power plants use coal. Nuclear power plants use nuclear materials like Uranium. The leftovers from the use of nuclear materials are known as nuclear wastes, which are radioactive. Uranium obtained from nature contains only 0.7% of Uranium-235, the element practically needed for reactors. The ore undergoes various steps to act as enriched fuel containing 3% Uranium-235. The fuel once loaded in a reactor runs for 6 months at a stretch. When discharged, it is cooled under water at the reactor site for a year or two and then shipped in shielded barrels either to permanent storage facilities or to a chemical reprocessing plant. Nuclear power plants do not pollute the environment by discharging smoke/ash as fossil fuel plants do, but the radioactive isotopes still contained in the spent fuel of the nuclear reactors are at stake. Spent fuels are highly radioactive, because a large number of radio-isotopes are present in it.

Fig 2 : Dangerous Radioactive Wastes within Shielded Barrels

Types of Nuclear Radiation

(a) Alpha particles : Alpha particles are helium nuclei consisting of two protons and two neutrons. They are emitted from naturally-occurring heavy elements such as uranium and radium. They are also emitted from some man-made transuranic elements and radioactive wastes. They cannot penetrate the skin, but are dangerous only if emitted inside the body.

(b) Beta particles : Beta particles are fast-moving electrons emitted by many radioactive elements including radioactive wastes. They are more penetrating than alpha particles, but easily shielded. The most energetic Beta particles can be stopped by a few millimetres of wood or aluminum. They can penetrate a little deep into human flesh but are generally less dangerous to human beings than gamma radiation. Exposure to Beta radiations produces an effect like sunburn, but which is slower to heal. The weakest of them, such as from tritium, can be stopped by skin or cellophane.

(c) Gamma rays : Gamma rays are high-energy beams much the same as X-rays. They are emitted in many radioactive decays and may be highly penetrating. So they require more substantial shielding. Gamma rays are the main hazard to people dealing with sealed radioactive materials used in industrial gauges and radiotherapy machines. Radiation dose badges are worn by workers in exposed situations to detect them and hence monitor exposure. All of us receive about 1mSv per year of gamma radiation from cosmic rays and from rocks.

(d) Neutrons : Neutrons may be emitted from nuclear fission and fusion. They are mostly released by nuclear fission. They are also found from radioactive decay, cosmic rays or particle accelerators. Large neutron sources are rare, and are usually limited to large-sized devices like nuclear reactors and particle accelerators. They are seldom encountered outside the core of a nuclear reactor. Thus normally they do not make any problem outside the nuclear plants. Fast neutrons can be very destructive to human tissue. Neutrons are the only type of radiation which can transform non-radioactive materials into radioactive materials.

Dangers of Nuclear Radiations

When atoms are split, a lot of energy is released. It sounds innocent enough, but nuclear processes produce dangerous radioactive materials having serious long term biological effects. They emit penetrating radiations that can cause damage to the molecules of living cells. The radiations dissociate complex molecules of living tissues through ionization. Cellular function(s) may be temporarily or permanently impaired and the cell may be killed by the effect of nuclear radiations. They

Fig 3 : Effect of Nuclear Radiations on Fish, Butterfly and Frog

induce cancerous growth, cause severe skin burns, leukaemia and disorders in the reproductive, immune, cardiovascular and endocrine systems of the human body. Exposure to radiation has been linked to genetic mutations and birth defects even upto five generations. Harmful radiations can kill vegetation, fishes and animals.

Radiation-Doses

The severity of the injury depends on the type of radiation, the dose, the rate at which the dose was absorbed, and the radio-sensitivity of the tissues involved. In order to quantify the radiation exposure in our daily lives and to assess its potential health impacts, it is necessary to establish a unit of measurement. The basic unit of radiation dose absorbed in living tissue is known as **gray (Gy)**. *One gray represents the deposition of one joule of energy per kilogram of tissue.*

Doses are also measured in ***rad***, 100 rads being equal to 1 **gray**. ***Rad*** *is defined as the dose when 1 kg of matter absorbs 0.01 joule of radiation energy.* However, neutrons and alpha particles cause more damage per gray than gamma or beta radiation. Therefore another unit, the **sievert** (Sv) is used in setting radiological protection standards. This unit of measurement takes into account biological effects of different types of radiation. Since the **sievert** is a relatively large value, dose to humans is normally measured in millisieverts (mSv), which is one-thousandth of a sievert.

One **gray** of beta or gamma radiation has one sievert (1 Sv) of biological effect.

One **gray** of alpha particles has 20 Sv of biological effect.

One **gray** of neutrons is equivalent to around 10 Sv.

Dose of more than 40 grays severely damages the human vascular system and causes death. A dose of 1.5 to 10 grays causes destruction of human bone marrow, leading to infection and hemorrhage. The injury may include degeneration or destruction of the irradiated tissue and the initiation of cancer. A human body exposed to nuclear radiations may have late effects. The most important late effect of radiation exposure is an increased incidence of leukemia and/or other types of cancers. Statistically significant increases in leukemia and cancers of the thyroid, lung, and the female breast have been demonstrated in populations exposed to radiation doses greater than 1 gray. Currently only the lower doses of radiation are effectively used in the medical practices.

Fig 4 : Effect of Nuclear Radiations on Human Child and Fruit

Radiation Doses (mSv/yr) and Effects

(Source : World Nuclear Association)

mSv/yr	Effects
2.4	Typical background radiation experienced by everyone
1.5 to 2.5	Average dose to Australian uranium miners and US nuclear industry workers
Up to 5	Typical incremental dose for aircrew in middle latitudes.
9	Exposure by airline crew flying the New York - Tokyo polar route.
10	Maximum actual dose to Australian uranium miners.
10	Effective dose from one abdomen & pelvis CT scan.
20	Current limit (averaged) for nuclear industry employees and uranium miners.
50	Former routine limit for nuclear industry employees, now maximum allowable for a single year (average to be 20 mSv/yr max). It is also the dose rate which arises from natural background levels in several places in Iran, India and Europe.
50	Allowable short-term dose for emergency workers
100	Lowest annual level at which increase in cancer risk is evident Allowable short-term dose for emergency workers taking vital remedial actions (IAEA).
130	Long-term safe level for public after radiological incident
170	7-day provisionally safe level for public after radiological incident
250	Allowable short-term dose for workers controlling the 2011 Fukushima accident.
250	Natural background level at Ramsar in Iran, with no identified health effects
350	Criterion for relocating people after Chernobyl accident (for lifetime).
500	Allowable short-term dose for emergency workers taking life-saving actions
680	Tolerance dose level allowable to 1955
700	Suggested minimum dose for maintaining evacuation after nuclear accident
800	Highest level of natural background radiation recorded, on a Brazilian beach.
1000	Short-term exposure may cause a fatal cancer many years later in about 5% people
5000	Short-term exposure would kill about half those receiving it within a month.
10000	Short-term exposure is fatal within a few weeks

Radioactive Waste Management

Nuclear waste being radioactive cannot be disposed anywhere unlike other industrial wastes. Very low level waste (VLLW) contains radioactive materials at a level which is not considered harmful to people or the surrounding environment. Low level waste (LLW) generated from hospitals and industry is suitable for shallow land burial. Intermediate-level waste (ILW) contains higher amounts of radioactivity and requires shielding. High level waste (HLW) arising from the burning of uranium fuel in a reactor is highly radioactive and hot. It requires cooling and shielding.

Fig 5 : Disposal of Radioactive Waste in Repository

Nuclear power is the fourth-largest source of electricity in India after thermal, hydroelectric and renewable sources of electricity. India has 20 nuclear power plants in operation with 6 nuclear power plants generating 4780 MW electricity. With this number of reactors India produces 5,000 cubic metres of HLW every year, in addition to thousands of cubic meters of intermediate and low-level nuclear wastes. As on 1st January 2014, there were 430 nuclear reactors considered to be in operation in the world contributing 16% of the world's total electricity production. With this statistics, the hugeness of the nuclear waste generated globally every year can be understood. Each year, nuclear power generation facilities worldwide produce about 2,00,000 cubic metres of low-level and intermediate-level radioactive waste, and about 10,000 cubic metres of high-level waste including used fuel designated as waste. Used fuel still contains some of the original Uranium-235 and various plutonium isotopes. This uranium and plutonium from the wastes can be separated by processing and recycled for re-use in a nuclear reactor. It lessens the risk of wastes. Major commercial reprocessing plants operate in France, UK, and Russia. Belgium, China, France, Germany, India, Japan, Russia, Switzerland and UK usually dispose the wastes after reprocessing.

Radioactive wastes remain biologically hazardous for thousands of years, beyond the span of any human institution. The wastes need a long-term safe storage. Thus the technology for waste management should be adequate enough for the present and the future generations as well. Permanent but potentially retrievable storage in deep stable geologic formations is the best solution. The wastes should be stored in well shielded, guarded repositories for later disposition or may be converted to very stable compounds, fixed in ceramics or glass, encapsulated in stainless steel canisters, and buried far underground in very stable geologic formations. The life span of radiation may be reduced using laser. Some nations like Sweden have started burying waste containing ceramic cylinders under sea for better result.

Public Opposition

No country in the world has found a permanent solution for proper disposal of the nuclear wastes. Building new plants means the production of more waste with nowhere for it to go. Storing radioactive wastes far underground may not put the dangers to an end. The phenomena like earthquake and volcanic eruptions could jeopardize the safety of a nuclear waste repository. The safety of such repositories is the subject of public controversy, especially in the geographic region in which the repository is located or is proposed to be built. For example, opposition from state residents and questions about the geologic stability of the proposed repository

at Yucca Mountain site have helped prolong government studies. Similarly, a $2 billion repository built in underground salt caverns near Carlsbad, New Mexico, is designed to store radioactive waste from the manufacture of nuclear weapons during the Cold War. This repository, located 655 meters underground, is designed to slowly collapse and encapsulate the plutonium-contaminated waste in the salt beds. For the time being, the disposal is within our control. But this may put us in hot water in future, if the world would primarily depend upon nuclear power. Our Kudankulam nuclear power plant in Tamil Nadu has faced local opposition for a quarter of the century and witnessed violent protests in 2012 by the local villagers.

Phasing Out Nuclear Power

In 1950's when people were thinking to reduce air pollution, nuclear energy was perceived as a cheap, plentiful and clean energy of the future. Even the utility industry believed that nuclear power would replace the increasingly scarce fossil fuels and lower the cost of electricity. People also favoured the mission hoping at least the transition of nuclear power from the field of war to peaceful uses. But the calculations went wrong. High construction costs, strict building and operating regulations, and heavy expenditure towards permanent and safe waste disposal make nuclear power plants much more expensive than the power plants that burn fossil fuels. The nuclear power industry has come under growing pressure to cut operating expenses and become more effective. Many countries have planned to phase out nuclear power completely. Sweden committed to phase out nuclear power very soon. France cancelled several planned reactors and was considering the replacement of aging nuclear plants with environmentally safer plants. Germany announced plans in 1998 to phase out nuclear energy. No orders for nuclear plants have been placed in the U.S. since 1978. The number of operating reactors worldwide has been reduced to 430 this year from 439 in the last five years.

Conclusion

Global warming and energy insecurity promote nuclear power as a clean and safe way to curb emissions of greenhouse gases and reduce dependence on foreign energy resources. But nuclear power generation process reveals nuclear power to be a dangerous and expensive form of energy that poses serious risks to human health and national security. We have double-crossed the nature. Often we forget that nature could support our need but not our greed and do injustice with nature. We have polluted our abode we live in, because of our impatience and lack of environmental consciousness before implementing a new technology. Even today, if we stop all the emissions completely, it will take not less than 1000 years to get a pollution free environment back. Therefore, we should look ten times before we leap a step forward. We must think often feasible safe methods for sustainable disposal of radioactive waste before setting up a nuclear power plant. Otherwise, we may hoist with our own petard one day.

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ANCIENT INDIAN ASTRONOMY AND ITS LAST MODERN HEIR

Prof. Sudhira Panda

Our beautiful Earth and unending blue sky are always with us, since birth till death, and surprisingly we never get fed up with them. Rather they remain with us as source of mystery and wonderment forever. From the beginning of the civilization people tried to unveil this mystery of the Earth, the sky and the heavenly bodies including Sun. Inheriting the oldest civilization of the Earth, many ancient great souls of India researched on them and passed their knowledge to the common people. The hall of fame includes luminaries like Aryabhatta, Barahamihir, Bhaskaracharya, Brahmagupta, Ganesh, Sudhakar Dwibedi, Satananda, Kamalakar Bhatta, Kutanacharya, Ellacharya, Bapudev Sastri and Madhab Mishra. They had their own *Siddhants*. Besides those many more might have contributed significantly to astronomy whose names were not recorded in the history, since their *Siddhantas* were not published.

Hindu astronomy is as old as the Vedas. The name of the great astronomers and their *Siddhants* are mentioned in history. Mainly five *Siddhants* are well-known in India, namely, *Surya Siddhanta, Brahma Siddhanta, Soma Siddhanta, Lomasha Siddhanta* and *Arya Siddhanta*. There is a myth about Surya Siddhanta, which says that the *Siddhantas* were the advices of the Surya vanshi to the demon Maya. So also the myth goes that *Brahma Siddhanta* was written by Brahma and published by Narada. Similarly *"Soma Siddhanta"* was written by Soma (Moon) and published by some unknown ancient sage. However, Lomasha Siddhanta was written and published by the great sage Lomasha himself and *Arya Siddhanta* was written and published by the great astronomer Aryabhatta.

Aryabhatta the inhabitant of Pataliputra (formerly Kusumapur and presently Patna in Bihar) wrote *Arya Siddhanta* at the age of 23 in 476 A.D. For the first time he discovered that the day and night takes place as the effect of the earth's rotation around its own axis. However, he couldn't prove it with strong logic. As a result he was insulted by the common people. He could establish his equation through experiment and theory. However, he is recognized as the first astronomical experimentalist in India.

Barahamihira was one among the nabaratna (nine Gems) in the court of the Great King Bikramaditya. In 505 A.D. he published his works *Brihat Sanhita, Pancha Sidhantika* etc. He was respected as a writer and unique collector. In *Brihat Sanhita* he compared *Siddhantas* with his own observation regarding Sun's movement in ecliptic. He for the first time fabricated instruments for celestial observation. He also gave a mathematical interpretation to those observations.

Brahmagupta of Rewa in 628 A.D. wrote *Brahmasphuta Siddhanta* at the age of 30. In this book he made some corrections to the old Siddhantas. The Hindu astronomy only came from *Brahmasphuta Siddhanta*. Brahmagupta was also a famous algebraist and algebra was spread to Europe through Arabic countries later on.

Pandit Sudhakar Dwibedi wrote *Ganak Tarangini* or *Manjala Grantha* in tenth century. Satananda, the great mathematician from (Jagannath) Puri, wrote the scripture Vaswati in 1099 A.D.. He for the first time introduced decimals in his astronomical calculation. The advent of Bhaskara from Sahyadri (some place in Western mountain range), marks an watershade in the history of ancient astronomy. His great work, *Siddhanta Siromoni* is one of the standard treatises of the Differential Calculus. *Karnakutuhala* is another important work of Bhaskara in astronomy. With the death of Bhaskara, the living breath of mathematical science and astronomy parted from India.

In seventeenth century King Jayasingh of Jaypore established many observatories in north India by taking the help of Euclid Geometry and it is he who translated Euclid Geometry into Sanskrit.

Kamalakar Bhatta, the grandson of Pandit Srikrushna Daibabit a courtier of Samrat Jahangir hailed in the sixteenth century. However, his scripture *"Siddhanta -Tatwa-Bibeka"* is just a supporting work to *"Surya Siddhanta"*. It rejects the idea of Bhaskarachary in *"Siddhanta Siromoni"*. Because of many complicacies this scripture didn't become popular. However, among all scriptures in the history only *Surya Siddhanta, Siddhanta Siromoni* and *Brahma Siddhanta* were referred to for the astronomical calculations.

The next 400 years was the dark age of Indian astronomy. The vacuum was filled by a person from the remote corner of Odisha who for a long time was not known even in his own native state. Khandapada, his birth place was a backward hilly feudal state in the then Odisha province. Mahamahopdhaya Samanta Chandrasekhar Singha Harichandan Mohapatra was born in 1835 A.D. of Lunar Pousa Krushnaastami.

The Political Background of Odisha

Before 1947 A.D. Odisha was under British Rule. It was divided into two categories, namely Khasmahal and Gadajat. Khasmahal consisted of the coastal region while Gadajat, consisted of 24 feudal states. Khasmahals were directly ruled by the British while Gadajat regions were ruled by the local chieftains directly responsible to the British government. Khandapada was one among those 24 Gadajats.

Chandrasekhar was the only son of Shyamabandhu Singha, the youngest son of seventh king Narasingha Mardaraja Bhramarbara Ray. As a member of the royal family he was known as Samanta. He was named Chandra Sekhar as his parents got the son by worshiping Lord Siva after the death of their two daughters and a son. As per superstition his parents sold him to a Muslim (pathan) priest to save him from death for which he is popularly known as Pathani Samanta.

The interest in the sky was almost an inborn quality with Pathani Samanta. In his childhood days he was interested in observing the vultures flying and hovering in the sky. With passage of time, his interest shifted to the astronomical observation of stars and planets. He got the preliminary knowledge of astronomy from his father Syamabandhu Singh Samanta. The astronomical scriptures he referred to were mostly written in Sanskrit. Therefore Chandrasekhar learnt Sanskrit from his guru Ananda Khadenga and studied the works on algebra, trigonometry and lilabati (one chapter on algebra in the scripture *Siddhanta Siromoni* of Bhaskara) written by the ancient mathematicians. At the age of 15, he could master all the theories behind the calculation of the movement of the heavenly bodies. He started calculations to predetermine the time of sunrise, sunset, solar eclipse and lunar eclipse and its time span. For these observations he mostly used his self-made instrument *Gola Yantra* (Armilary Sphere).

Samanta was observing the stars and planets of clear autumn night sky, sometimes from his courtyard or by making holes and setting bamboo pipes in the thatched roof. While observing the position and movement of pole star, Ursha measures, Cashiyopia, Constellions, Venus, Jupiter, Mars, Mercury and their respective rising and setting times, he noticed that there were errors in calculations in old *sidhantas*. He decided to make the correction, for which he worked from age fifteen to twenty-three. In those days, he used to observe the heavenly bodies in the night sky and were recording his findings on palm leaves in the daytime. He also verified the statement in Atharva Veda that the distance from sun to earth is one hundred fifty four times more than the distance from moon to earth.

Samanta's findings contradict those old geocentric planetary models followed by all Indian astronomers, the models given by Ptolemy and the Helicentric modern planetary model of Newton-Kepler. According to Samanta, all the planets except Earth are revolving around the Sun and the Sun with other planets revolves around stationary Earth. The model is smilar to that of Tycho Brahe. Surprisingly all the findings are almost similar, since all of them used the relative co-ordinates in their respective calculations.

He has recorded his findings in his scripture Sidhanta Darpan. The important corrections are mentioned in Tables 1 & 2.

Table - 1 : Sidereal Periods in mean Solar Days

	Eurpoean Astronomy	Surya-Siddhanta Difference	Siddhatna-Siromani Difference	Sidhanta Darpan Difference
Sun	365.25637	356.25875+.00238	365.254843+.000206	365.25875+.00238
Moon	27.32166	27.32114+.00001	27.32114-.00052	27.32167+.00001
Mars	686.9794	689.9975+.0181	686.9979+.0185	686.9857.0063
Mercury	87.9692	87.9585+.0107	87.9699+.0007	87.9701+.0009
Jupiter	4332.5848	4332.3206-.2642	4332.2408-.3440	4333.6278+.0430
Venus	224.7007	224.6985-.0022	224.9679-.0028	224.7023+.0016
Saturn	10759.2197	10765.7730+6.5533	10765.8152+6.5955	10759.7605+.5408

Table - 2 : Comparison of the Mean Inclinations of the Orbits of the Planets to the Ecliptic

	Eng. Ast.	Surya-5	Siromani	Darpana
Mercury	7 0' 8"	5 25	6 55	7 2
Venus	3 53 35	2 46	3 6	3 23
Mars	1 51 2	1 30	1 50	1 51
Jupiter	1 18 41	1 0	1 16	1 18
Saturn	2 29 40	2 0	2 40	2 29
Moon	5 8 48	4 30	4 30	5 9
Oliquity of the Ecliptic	23 27	24 0	24 0	23 30

Samanta discovered three irregularities in Moon's motion. He had made measurements and made three corrections to the old siddhants as regards the motion of the Moon. He named those irregularities as (i) Tungantar (Eviction), (ii) Pakshika (Variation) , (iii) Digamsa (Annual equation).

Samanta recommended various corrections to be incorporated as to the mean position of planets for obtaining their true positions and accordingly had prescribed for the computations of astronomical predictions which are supposed to remain valid for thousands of years.

Planet Venus moves over the solar disk seen as small pebble during a transit . Last transit of venus was in 1882 which was not visible to India. According to samant's prediction next transit of Venus was due on 8th June 2004.

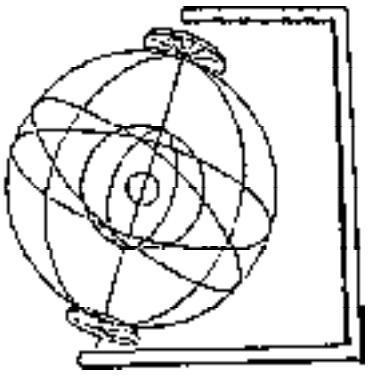
It is interesting to know that the instruments which Samanta Chandrasekhar was using to observe the heavenly bodies or to measure the height and distance of the distant objects, were improvised using cheaply available natural materials such as bamboo chips and wooden sticks. They were so disarmingly simple in construction that the modern man

can hardly accept those as instruments. Those instruments are locally known as *Mana Yantra, Golayantra, Dhanuryantra, Shanku, Surya Ghadi, Chapayantra, Golardhayantra, Chakrayantra* and *Swayangwaha Yantra*. These instruments are briefly introduced below.

Mana Yantra: It is a T-shaped instrument made of two sticks, one standing vertical to the other. Former one got holes or marks in each unit. The observer can determine the height and distance of a distant object simultaneously by observing the object inside those holes taking two readings from different positions. This is the instrument which made Samanta popular among the common people of Odisha since its working principle is very simple based on rudimentary geometry.

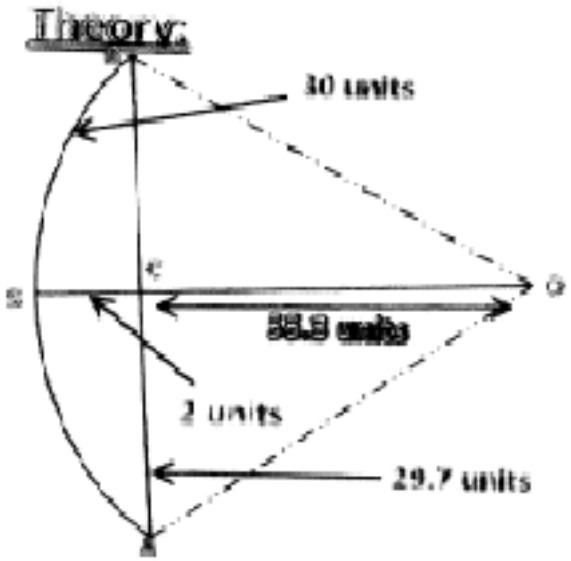
Mana Yantra

Golayantra : It is a replica of earth surrounded by the sky. In other words it represents a globe surrounded by the celestial sphere. As we know the globe is used to locate a place on the earth through imaginary latitude and longitude lines on it. Similarly imaginary lines are drawn across celestial sphere to determine position, motion and their respective rising and setting times of heavenly bodies throughout the year.



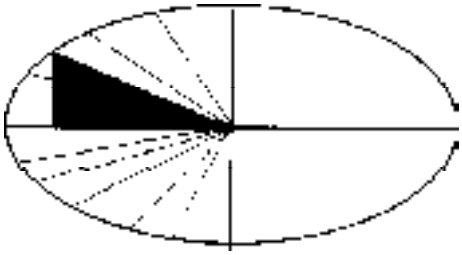
Gola Yantra

Dhanuryantra: It is an instrument which was fabricated by Samanta Chandra Sekhar in a few minutes by the help of coconut strings. He improvised it impromptu to prove his point in way of an answer to the question "What's the angular distance between Mars and Venus ?" The gentleman (Prof Roy), well- versed in astronomy, was actually testing him. Pat came the reply from Samanta, "6°".



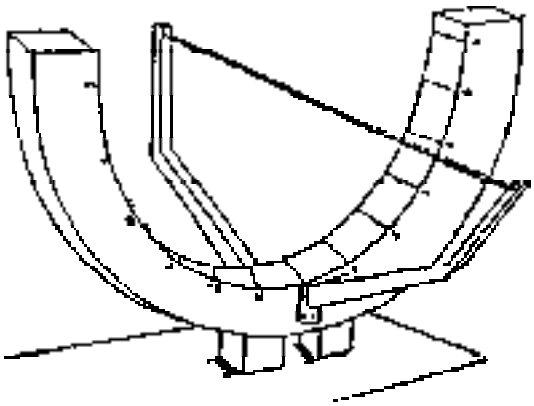
Sanku: It is difficult to believe in this age of highly sophisticated machines and instruments, that this is an instrument. It is a single stick standing vertically upward on the plane ground. From the position and length of its shadow we can determine the exact directions of the place, latitude of the place and declination and longitude of Sun throughout the year.

Surya Ghadi: It was fabricated by Samanta Chandra Sekhar and established by Prof, Jogesh Chandra Roy in Ravenshaw College (now Ravenshaw University). It has been showing correct local time since 1902.



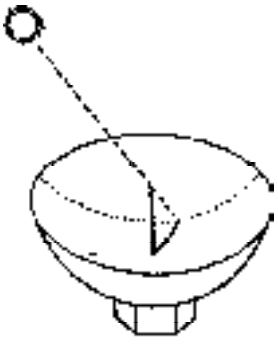
Surya Ghadi

Chapayantra: It gives informations on time, date and month with equal accuracy like the highly complex and expensive Jantarmantar observatory located at New Delhi.



Chapa Yantra

Golardhayantra : It was designed by Samanta by using the lower part of the circular water pot and a stick of length equivalent to the radius of the pot inserted vertically upward at its center. This shows equally accurate time as the other sundials.

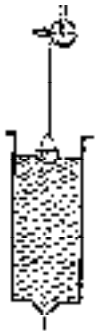


Golardha Yantra

Chakrayantra: It is also a Sundial fabricated by Samanta following the similar principle of parallel axis to axis of rotation of earth and plane parallel to the equatorial plane.

Chakra Yantra

Swayambahayantra : It is an instrument consisting of a container filled with water and an indicator plate connecting with a pot floating on the water. Continuous evacuation of water with a constant rate indicates constant time interval in the indicator plate. Samanta was keeping this instrument all the time with him, since it can work in both day and night time independent of sky conditions (whether cloudy or clear, sunny or night).



Swayambahu Yantra

Pathani Samanta, the rare genius would have been lost to the world had he not been discovered by Radhanath Roy. Radhanath Roy was then a school inspector. He was visiting the schools of Khandapada. In passing it may be mentioned that Radhanath Roy is considered as the founder of modern odia literature. Before his discussion with Samanta, like the local people, Roy mistook Samanta as a mere astrologer. After returning from Khandapada Radhanath Roy talked to Madhusudan Rao (another precursor of modernism in Odia literature), and they together wrote to Mahesh Chandra Nyaratna

the principal of Sanskrit College, Calcutta and invited him to Odisha to test the knowledge of Pathani Samanta. After long discussion with Pathani Samanta at Cuttack M. C. Nayaratna was convinced about Samanta's sound knowledge in Sanskrit. He assigned Prof. Jogesh Chandra Roy 'the professor of science' in Ravenshaw College, Cuttack the task of testing the scientific authenticity of Samanta's work. Prof. Roy not only tested Samanta's knowledge but he became a disciple of Samanta to learn astronomy. Samanta Chandra Sekhar's achievements written in palm leaf scripture took the form of a book by the combined effort of Radhanath Roy, Madhusudan Rao, Mahesh Chandra Nyaratna and Prof. Jogesh Chandra Roy. It was published with the financial support from the king of Athamallik Sri Mahendra Deo and the king of Mayurbhanj Sri Ramachandra Deva in 1894 A.D. All total Rs 1250/- had been spent to get 5000 copies of Sidhanta Darpan printed in Debanagari script. The introduction to the Siddhanta Darpan running into 61 pages was written in English by Prof. Jogesh Chandra Roy. The copies were distributed in England (700 copies), France (300 copies), Germany (1000 copies) and America (800 copies) in 1899 A.D. The title Mahamahopdhya was conferred upon him by the British Government on 28th Sept. 1993 A.D. in a Darabar specially arranged at Cuttack (the then state capital of Odisha) as Samanta an orthodox Hindu refused on religious ground to travel to Calcutta to receive the award.


SANAD.

Siddhanta Darpan

Siddhanta Darpana contains 24 chapters with 2506 slokas , out of which 2290 verses composed by Samanta and 216 citations from earlier authors. It contains 55 tables, each tables contains more than 50 numbers sometimes given up to five places in sexagesimal system. All this shows his amazing computational skill and ability to carry out enormous calculations using large numbers without any aid.

Two articles were published in the international journals, Nature Vol-59, March 1899,No.l532, pp. 436-437 and Knowledge Vol-XXII, January-December 1899, pp. 256-258 regarding Samanta Chandra Sekhar and Siddhanta Darpan . Excerpts from Nature and Knowledge (above mentioned issues) respectively are given in following tables and paragraphs.

Summary of contents of Siddhanta Darpan

Chapter No.	Name of the section	Contents	No. of slokas
1	Madhyamadhikara	Description of time	55
2		Description of Bhagana etc.	25
3		Mean planet position	77
4		Various corrections	57
5	Spastadhikara	True planet position	221
6		Finer corrections	161
7	Triprasnadhikara	Gnomos etc.	95
8		Lunar eclipse	87
9		Solar eclipse	78
10		Parilekha description	137
11		Transit of planets	111
12		Alignments of planets	93
13		Rising and setting of planets	85
14		Phases of Moon	68
15		Description of Mahapata	71
16	Goladhikara	A set of question on Sun and Earth	80
17		Description of earth	160
18		Description of earth (contd.)	176
19		The celestial sphere	124
20		Description of instruments	112
21		Some deeper questions	251
22	Kaladhikara	Description of year etc.	77
23		Prayer to Purusottam(Lord Jagannath of Puri)	56
24		Conclusion	154
25	Additions	Transit of venus	5

Anyone who reads the very interesting introduction of sixty one pages that Prof. Roy has attached to this Sanskrit work will regret very much his inability to fathom the work that follows. For therein is contained the results of the patient and industrious inquiry of one who unaided by the accumulated knowledge of western astronomers, resolutely set himself to solve the problems of celestial mechanics by the aid of such instruments as he could fashion himself and where the time honored clepsydra supplied the place of the sidereal clock. The only assistance he seems to have had were the similar rough observations of Bhaskara (born 1114 A.D.) and some still older observers. Prof. Roy compares the author very properly to Tycho. But we should imagine him to be greater than Tycho, for without same assistance, without encouragement of king and the applause of his fellows, he has advanced

his favorite science quite as effectively as did the Danish astronomer. It is especially curious to note that the system at which Chandrasekhar ultimately arrived, and the explanations he offers of it, bears a very considerable resemblance to that Tycho taught. The author has never been able to convince himself that the Earth turns on its axis, or that goes round the Sun, but to the planet, he assigned heliocentric motion, much as Tycho did.

Knowledge: "The ephemerides computed from his elements are seldom more than a few minutes of arc in error, whilst the Bengali almanac may be in error as much as four degrees. To Hindus, for whom their religious observances are regulated by astronomical configurations, this work, by none of themselves, a strict follower of the secret laws of their religion, and conducted throughout solely by traditional Hindu methods, is of the highest importance, as it removes the confusions which had crept into their system, without in the least drawing upon the sources of western science. But the work is of importance and interest to us and to the westerners as well. It demonstrates the degree of accuracy which was possible in astronomical observation before the invention of the telescope, and it enables us to watch, as it were one of the astronomers of hoary, forgotten antiquity actually as his work before us today.

It will not be out of context to mention the opinion of Prof. Jogesh Chandra Roy in the last paragraph of his introduction to Siddhanta Darpan . That is " And what did our Indian Tycho receive ? He met with sneers from his equals in positions, because he shock off the aristocratic prejudice against star gazers and fortune-tellers. He had no one to encourage him in his pursuit, and no notice was taken of his work. Our Government could only confer upon him an empty title which he had never coveted. Geniuses are like delicate plants, never plentiful anywhere, and depend upon tender care for growth and development and fertility. Let me therefore hope that the past neglect of his countrymen may yet be compensated and that better day may yet down upon our old dandy crippled observer of heavenly body.{KATAK, 1889}"

However, Prof. Roy's wish and effort was agreed by the Government to give pension Rs. 50/- per month to Chandrasekhar. Unfortunately the first and the last instalment of the pension was spent for his funeral at Puri on 11th June 1904.

Acknowledgement:

The author is thankful to Sri Sailaj Rabi for the critical reading of the manuscript and valuable suggestions.

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DEVELOPMENTS IN INDIAN SATELLITE TECHNOLOGY AND ITS APPLICATIONS

Prof N. K. Mahalik

Introduction

Twenty-first century is an age of satellites. All modern activities depend on satellites of one type or other. They provide information on earth resources (forests, water, agriculture, mineral resources, terrain condition etc) at the shortest possible time and at a lower cost. They give informations on weather conditions, natural and other hazards. Anything happening on Earth and beyond the Earth are quickly transmitted to the human society by communication satellites. Most of the human activities are now conducted on-line. With the development of satellite the Earth has become a small place and easily accessible to all. With a computer at hand, most things can be done, sitting at home.

What is Remote Sensing

In a broader sense it is sensing natural resources, meteorological events and human and other events and activities from a distance without going to the place where the actual things occur or happen. The simplest model of remote sensing is observation of things by human beings shown in Fig.1.

The figure shows how a human being senses everything before him. He sees forests, water bodies, human settlements, cloud cover, rainfall, congregation of people, their activities, and temperature effects, though his vision is limited to a small area. What is the mechanism of all these? He has three sensors, the eyes to see, the ears to hear and the skin to feel the heat or cold. For seeing things he needs some light such as solar energy or some artificial light. Thus some sort of radiation is necessary. Human eyes can see the objects within the visible range of the spectral band of the electromagnetic radiation i.e. within the wave lengths of 0.04 micron to 0.07 micron. In satellite remote sensing the same model is followed where the electromagnetic radiation (EMR) in all the spectral bands are used by artificial eyes (sensors, radiometers and transponders) placed aboard the satellite

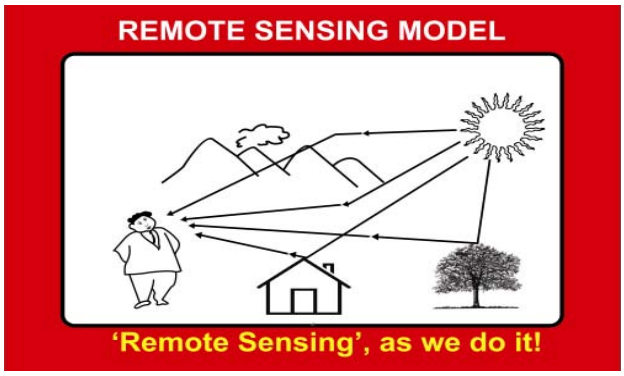

Fig.1

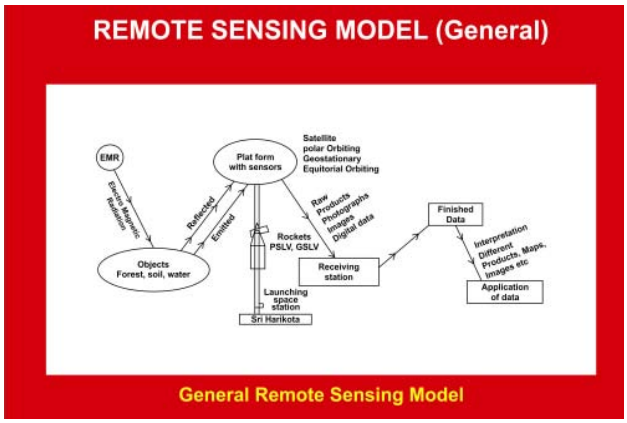

Fig.2

moving in the space. A more generalized remote sensing model is shown in Fig.2.

In this case the human is replaced by a satellite with sensing devices such as sensors, radiometers and transponders placed high up in the space. Its higher position in space enables it to see large areas of the earth's surface and can monitor temporal changes. The various sensing devices (sensors, radiometers and transponders) operate in different bands of the EMR. (Fig.3 & 4).

Type of Sensors

There are different types of sensors or payloads to serve different purposes such as

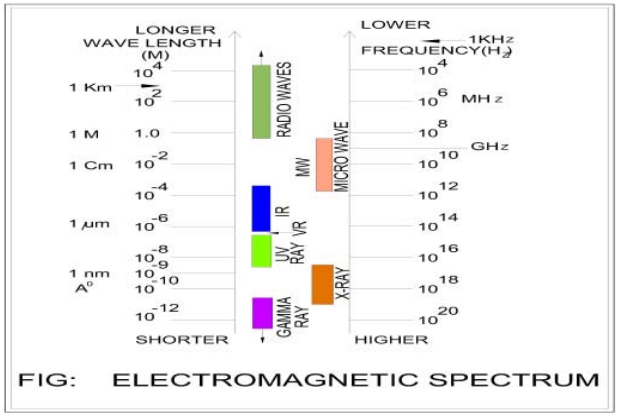

Fig. 3 shows the total electromagnetic radiation with different wave lengths beginning with Gamma-Rays, X-rays, Ultra-violet Rays, Visible Ray, Infrared, Micro wave and Radio waves.

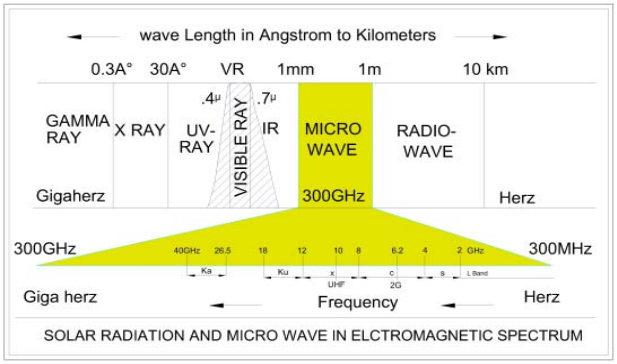

Fig.4 shows the different frequencies in the micro-wave which are used for radiometers and transponders etc.

remote sensing of natural resources, measuring weather conditions and transmitting information from one place to another.

Resource sensing sensors: These are a variety of cameras and scanners (multispectral scanners, line imaging scanners and thematic-mappers) operating in visible and infrared segment of the EMR. The weather sensing devices are radiometers which operate in infrared and microwave segments of the EMR. The communication payloads, known as transponders, operate in different microwave bands e.g., L, S, C, X, Ku and Ka bands.

Type of Satellites

There are three type of satellites based on their applications and two types based on their orbital positions.

(1) **Satellites based on their applications:** They are three types: Remote sensing satellites which exclusively sense earth resources such as water, forest, mineral, terrain features etc. They map the resources and also monitor changes with time. The Indian remote sensing satellites are: IRS series, cartosat series, and radar imaging satellites (Raisat). The other two categories are weather and communication satellites. Initially the INSAT series of satellites were jointly serving both weather and communication but later developmental changes brought in independent weather and communication satellites such as metsat, and meghatropics for weather and Gsat and Edusat for communication. The weather satellites carried a variety of radiometers while the

communication satellites carried a variety of transponders working on many frequency bands of the Microwave radiation.

(2) **Satellites based on orbit:** These are two types : Polar orbiting Sun synchronous satellites and equatorial orbiting geosynchronous satellites. The polar orbiting satellites are placed at a relatively lower altitude (500 to 1500 km above the Earth's surface) which move round the globe and repeatedly see a particular region in each orbit at the same sun angle. So while it maps a region, it also monitors the changes in the region with time. This is good for mapping of forest areas, agriculture and water resources and monitoring their changes with time. The Geosynchronous satellites are equatorial rotating and placed at a higher altitude of about 36000 km above the Earth. It constantly focuses on a particular region of the Earth and records continuous changes with time such as weather changes in a region. While IRS series, Cartosat series are polar orbiting Sun synchronous satellites, INSAT, Gsat and Edusat are geosynchronous satellites.

Satellite Launch Vehicles

In all varieties of satellite sensing operations, rockets are needed to lift the satellites to the right orbital positions. From a modest beginning of small rockets carrying about 10kg materials, India has advanced through time to produce rockets to lift heavy weight satellites in to space. There are two principal types of launch vehicles: the Polar Satellite Launch Vehicle (PSLV) and the Geosynchronous Satellite Launch Vehicle (GSLV). Recently India had the privilege of joining the elite club of five (USA, Russia, France, Japan and China) with it own Cryogenic engines to lift heavy geostationary rockets. The successful launch of the communication satellite, GSAT-14 by indigenously developed GSLV-D5 with its own cryogenic engine is a big milestone in the developmental history of satellite technology of India.

Establishment of Launch Pad at Sriharikota

Earlier the Indian satellites were launched from foreign base in the absence of launching station and suitable launch vehicles. But with time India has achieved great success in launch vehicles such as PSLV and GSLV and an international class launching station at Sriharikota in Andhra Pradesh. All the satellites are now launched from Sriharikota launch station which has been named as Satish Dhawan Space Centre. Many foreign satellites are now launched from this center.

Satellite Data Receiving Center

A satellite data receiving centre has been established at Sadnagar near Hyderabad where satellites dump their data which are initially processed there and are sent to National Remote Sensing Agency at Hyderabad for further processing and distribution to different users.

Many sister organization such as research wings, satellite tracking centers have been

developed under the master organization known as Indian Space Research Organization (ISRO) under the Dept of Space, Govt. of India.

Progress in Indian Satellite Technology

India has achieved great success in the field of satellite technology within the last 50 years. From nothing in 1960s it is now a world leader in the fields of satellite technology. It has developed its own satellites, its launch vehicles, the various payloads and the international standard launching station. It has done great research to understand each segment of the electromagnetic radiation and their use in design of different pay loads. Earlier in seventies it took all the help from foreign countries to design, build and lift the satellites into space but now it is in a position to help developed countries to lift their satellites from its own launching center. India has very successfully accomplished its moon mission, Chandrayan in 2008 and in 2013 it has successfully launched a mission to Mars by its launch vehicle which is likely to reach Mars orbit by Sept 2014. Very recently in January this year (2014) it has successfully flown its heavy weight GSLV-D5 rocket by domestically producing its own Cryogenic engine. With the unusual success in the field of remote sensing within the last 50 years it is really difficult to predict to what extent India can go within the coming century. May be the Indians will be flying in deep space.

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TOWARDS SUSTAINABLE DEVELOPMENT WITH VEDIC PRINCIPLE OF ECOLOGICAL HARMONY

Nihar Ranjan Acharya

In the latter half of 20th Century-Environmental Science and Ecology, the disciplines of modern science have come up, under which the study of environment and its related fields is done with minute details. But, their origin can be seen long back in the Vedic and Ancient Sanskrit literatures. The concept of environment differs from time to time, since it depends upon the conditions prevalent at that particular time period. The Environment (Protection) Act, 1986 defines the Environment as - 'Environment includes water air and land and the inter-relationship which exists among and between water, air and land and human beings, other living creatures, plants, micro organisms and property'.

From the above definition, it can be well understood that Environment consists of two components namely biotic (living organisms) and abiotic (non-living materials). The living organisms can be grouped into three types: those living mainly on land (terrestrial or *Bhuchar*), in water (aquatic or *Jalachar*) and in air (aerial or *Khechar*). The non-living materials of the Environment are land, air, water etc.

The word *'Paryavarana'* which is frequently used for Environment has originated from Sanskrit literature and it carries the

meaning "which encircles us", that is all around in our surroundings. In Atharva Veda, words equivalent to this sense such as *Vritavrita, Abhivarah, Avritah, Parivrita*, etc. are used.

Vedic view on environment is well-defined in one of the verses of the Atharva Veda where three coverings of our surroundings are referred to as *Chhandansi*, means coverings available everywhere. It teaches us to wisely utilize the three elements which are varied, visible and full of qualities, viz., water *(Apah)*, Air *(Vayuh)* and plants and herbs *(Vanaspatayah)*. They exist in the World *(Prithivi)* from the very beginning. It undoubtedly proves the knowledge of Vedic Seers about the basics of Environment.

According to one indigenous theory established in the Veda and Upanishad, the Universe consists of five basic elements (the *Pancha Mahabhuta*) viz., Earth or Land (*Khit*), Water (*Apah*), Light or luster (*Tej* or *Agnih*), Air (*Vayuh*) and Ether (*Byoma* or *Akash*).

In Nature, there exists an inbuilt mechanism of balancing these five constituents or basic elements and living creatures on earth. A disturbance in percentage of any of these constituents of the environment beyond certain limits disturbs the natural balance and any change in the natural balance causes lots of problems to the living creatures in the universe. All constituents of the Environment are connected with a subtle web with one another. The relation of human being with environment is very natural as he cannot live without it. From the very beginning of creation man wants to know about it for self protection and self survival. Our Vedic Philosophy which is otherwise known as Sanatan (Eternal) Darshan (Philosophy) considers Vedic Aryans as children of nature. They studied nature closely in sylvan surroundings - very minutely. The verse *Ritam Badisyami, Satyam Badisyami* which means I will tell about the laws of nature and I will speak the truth; is the *Pramana* (Proof) of their study. *Ritam* is defined variously by different Vedic Contexts, but in general sense it has been elaborated as great 'cosmic order' which is the cause of all motion and existence, and keeps world in order. No one can ignore it, even *Devatas* (celestial bodies) are abided by the Ritam - the cosmic law and they are born of Ritam. It is the controlling and sustaining power that acts behind all natural phenomenona. It sustains sun in the sky. As Universal Laws it governs everything. The whole of the universe is working under *Ritam*.

Sand-storm and cyclone, intense lightening, terrific thunderclaps, the heavy rush of rain in monsoon, the swift flood in the stream that comes down from the hills, the scorching heat of the sun, the cracking red flames of the fire, all witness to a supreme power i.e. beyond man's power. The Vedic sages felt the greatness of these forces. Therefore, they worshiped and prayed them due to regard and gratitude. They realized instinctively that action, movement, change, creation and destruction in nature are the results of forces beyond men's control and thus they attributed these towards divinity of nature. The laws behind all natural phenomena are eternal and fresh phenomena are continually

reproduced, but the principle of order remains the same. Therefore, the principle existed already when the earliest phenomena appeared.

The main part of Rig Veda belongs to Natural hymns, the hymns related with natural forces. The hymns addressed to deities (*Devatas*) who are under the influence of the most impressive phenomenon of nature and its aspects. The word *Devatas* means divine entities which is helpful to all without any selfish gain. In these hymns, we find prayers for certain natural elements such as air, water, earth, sun, rain, dawn etc. The glorious brightness of the sun, the blaze of the sacrificial fire, the sweep of the rain-storm across the skies, the recurrence of the dawn, the steady currents of the winds, the violence of the tropical storm and other such natural energies, fundamental activities or aspects are glorified and personified as divinities (*Devata*). The interaction with nature resulted in its appreciation and prayer ...but, indeed, after a good deal of observation. Attributes assigned to deities fit in their natural forms and activities, as Soma is green, fire is bright, air is fast moving and sun is dispenser of darkness. The characteristics of these forces described in the verses prove that Vedic Seers were masters of natural science.

Rishis - the Vedic Seers had a great vision about universe. The universe consists of three interlinked webs, viz., *Prithivi*, *Antariksha* and *Dyava*. *Prithivi*, the Earth, *Antariksha*, the aerial or intermediate region which is between heaven and earth, and *Dyava*, the heaven or sky is very well established in the Vedic texts. *Prithivi* can be a scientific name - 'observer space'. It is our space, the space in which we live and die whatever we can see and observe. All living creatures come under the universal principle of: *Asti, Jayate, Bardhate, Biparinamate, Apakshiyate, Nasyati*. It means, it is there *(Asti)*, then it takes birth *(jayate)* then it grows *(bardhate)*, then it starts to turn reversely *(biparinamate)*, then it starts to decay *(apakshiyate)* and at last it decomposes *(nasyati)*. *Dyava* can be termed as 'light space' because light propagates in this space. *Antariksha* can be termed as 'Intermdediate space' as this space exists in between observer space and light space.

The concept of the form of the earth in *Rig Veda* is very fascinating. There is one small hymn addressed to *Prithivi*, while there are six hymns addressed to *Dyava-Prithivi*. *Prithivi* is considered the mother and *Dyava* is considered as Father and they form a pair together. One of the most beautiful verse of the *Rig Veda* says, 'Heaven is my father, brother atmosphere is my navel, and the great earth is my mother. Heaven and earth are parents: *Matarah, Pitarah, Janitarah* in union, while separately called as father and mother. They sustain all creatures. They are great and widespread. In *Atharva Veda*, the earth is described in one hymns called as *Bhumi Sukta* or *Prithivi Sukta* which indicates the environmental consciousness of *Vedic Rishis*. Through this hymn it appears that *Rishis* had advanced knowledge about the Earth. Earth is called as *Vasudha* for containing all wealth,

Hiranyagarva for having gold and treasures. The earth is called *Visvambhara* because it is the representative of the universe. This wide earth supports all varieties of herbs, oceans, rivers, mountains, hills etc. The earth is fully responsible for our food and prosperity. It is praised for its strength. It serves us day and night tirelessly.

Water is essential and precious to all forms of life. According to *Rig Veda*, water as a part of human environment occurs in five forms, viz., Rain Water *(Dvyah)*, Natural Spring *(Sarvanti)*, Wells and Canals *(Khanitrimah)*, Lakes *(Svayamjah)*, Rivers and Oceans *(Samudra)*. There are some other classifications also in the *Taittiriya Upanishad*, *Aranyakay Yajur Veda* and *Atharva Veda* as drinking water, medicinal water, stable water etc. The *Chhandogya Upanishad* describes the qualities of water. The water is the source of joy and for living a healthy life. It is the immediate cause of all organic beings such as vegetations, insects, worms, birds, animals, human beings etc. Even the mountains, the earth, the atmosphere and heavenly bodies are water concretized.

The cycle of water is described. From ocean water reaches the sky and from sky it come back to earth. *(Atharva Veda, 4.27.4.)*

According to *Atharva Veda*, *Vayu* cannot mean air alone. Apparent meaning of *Vayu* is air. The *Vedic* seers knew the importance of air for life. They understood all about the air in the atmosphere and also about the air inside the body. The *Taittiriya Upanishad* throws light on the presence of five types of wind inside the body: *Prana, Vyana, Apanna, Udanna, Samana*. *Rig Veda* mentions - 'Oh Air! You are our father, the protector. Air has medicinal values. Let wind blow in the form of medicine and bring me welfare and happiness. Another verse describes characteristics of air - The air is the soul of all deities. It exists in all as life-breath. It can move everywhere. We cannot see it. Only one can hear its sound. We pray to *Vayu Devata*. Vedic Arayans, therefore, emphasized that the unpolluted, pure air is the source of good health, happiness and long and cherished life. *Vayu Devata* is prayed to blow with its medicinal qualities.

Modern Environmentalists discuss sound or noise pollution. There is a relation between ether and sound. The sound waves move in the sky at various frequencies. Scientists could see the sky which exists only in the vicinity of earth. *Taittiriya Upanishad* throws light on two types of ether, i.e. *Mathakash* and Chidakash; i.e., one inside the body and the other outside the body. The ether *(Akash)* inside the body is regarded as the seat of mind. So, the *Yajur Veda* advises humanity not to pollute the sky.

Decades ago, when environment was not a buzz word, Vedic Philosophy through Isho Upanishad had taught us that one should enjoy renouncing or giving up others their part (vide its first Mantra) ... *"Tena tyaktena bhunjitha ma gridhah kasya swid dhanam."*

Modern Scientists are astonished and at the same time feel proud of Vedic Philosophy for its knowledge, wisdom and views about environment. Ancient Seers knew various aspects of environment, cosmic order, and also the importance of co-ordination between all natural laws for universal peace and harmony. When they pray for peace at all level in the *Shanti Mantras*, they express their belief about the importance of inter-relationship among all natural laws, people, regions. *The Shanti Mantra, 'Sarve Bhavantu Sukhinah, Sarve Santu Niramayah, Sarve Bhadrani Pasyantu Ma Kaschit Dukhah Bhag Bhavet'* -says that not only regions, water, plants trees, natural laws and energy, but all creatures should live in harmony and peace. Peace should remain everywhere. It is pretty clear that Vedic vision to live in harmony with environment was not merely physical but was far wider and sensitive. The Vedic people desired to live a life of hundred years *(Jivema Sarad Sata, Pasyame Sarad Satam... Rig. Veda)* and this wish can be fulfilled only when environment would be unpolluted, clean and peaceful. The knowledge of Vedic Philosophy is meant to save the humanity from falling into utter darkness of ignorance. The unity in diversity *(Sa Gachhadhwam, Sa Badadhwam .... Rig. Veda)* is the message of Vedic physical and metaphysical sciences. Essence of the environmental studies in the Vedas can be put here by quoting a partial mantra of Ishoupanishad, Mantra, 1*(Ishavasya Midaam Sarvam.....)*. The message is clear that environment belongs to all living beings, so it needs protection by all, for the welfare of all. Hence, for global harmony, Vedic seers always pray for the welfare of all creatures and all regions.

Challenges facing mankind on the environmental front have become truly global and pressing. Apprehensions are expressed that without remedial measures, we may face the bleak prospect of the collapse of the lifestyle that different societies presently enjoy. On the other hand, never before in the history have there ever been attempts on the same scale as we witness today, of the third world countries seeking to usher in socio-economic development to provide for people, the means to realize self fulfillment and create a society which is genuinely harmonious and free from want and deprivation. It is increasingly realized that the human race is standing at the crossroads in choosing the options it has in the areas of environment and development. The industrial countries, having enjoyed more than their share of development, have achieved a decent standard of living. This has given to the earth pollution and eco-degradation as a result of affluence and underlying greed. It has now become clear that such patterns of development, life styles and quality of life are unsustainable. On the contrary, the developing countries are still struggling for minimum levels of sustenance. No doubt, they too have contributed to the eco-degradation and pollution, but this is essentially need and poverty based. Before we reach a point of no return, we must take tangible steps and follow a road that leads to sustainability.

So, I would like to conclude with briefing up the Vedic Philosophy of harmony and sustainability.

Since time immemorial, Indians have been very conscious of environment. For Indians, the relationship with the nature starts every morning, when many recite the most powerful *Gayatri Mantra* as invocation to the Sun to the system we all belong. The Vedic Gods such as *Agni* (fire), *Surya* (Sun), *Vayu* (Air), *Bhumi* (Earth), *Varuna* (Water) and Indra (The God of Rain), together represent atmosphere, hydrosphere, lithosphere and sunlight and energy.

Long before ecology became the refrain of the global song at Stockholm and Rio, in ancient India - our Vedic Civilization had already a sacred space for the environmental ethos. The Vedic Tradition had always promoted the principle of ecological harmony centuries ago -not because the world was perceived as heading for an environmental disaster, nor because of any immediate utilitarian exigency, but through its quest for knowledge and physical symbiosis, synthesized in a system of ethical awareness and moral responsibility. The *Vedic Hymn* to the Earth, the *Prithivi Sukta* in *Atharva Veda* is undoubtedly the oldest and the most sensible environmental invocation. One of the Mantra says *'Mata Bhumih Putro Aham Prithibyah'*, which means Earth is my mother, I am the Son of Earth. Earth -the Mother is celebrated for all her natural bounties and particularly for her gifts of herbs *(Banaspati)* and vegetation.

Ishoupanishad (... Tena tyktena bhunjltha ma gridhah kasya swid dhanam) teaches us about 'sustainable development'. In short Environmental degradation is drawing everybody's attention now-a-days. In the race for growth, our environment has been subjected to constant damage. To sustain economic growth and development; policies, regulations and incentives need to be reestablished along with Vedic Principle of ecological harmony which is a need of the hour.

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WHY SACRED GROVES ARE IMPORTANT FROM SOCIO-ECOLOGICAL POINT OF VIEW ?

Prof. Madhab Chandra Dash

The Concept

Sacred groves comprise of patches of forests or natural vegetation consisting of a few trees to larger areas of forests- that are usually dedicated to local folk deities or tree gods (*Vana Devatas*).

These areas are protected by local communities because of their religious beliefs and traditional rituals (Figure 1) that run through several generations. This is the socio-cultural concept of the sacred groves. The degree of sanctity of the sacred groves varies from one grove to another. In some groves even the dry foliage and fallen fruits are not collected. People believe that any kind of disturbance may offend the local deity, causing diseases, natural calamities or failure of crops. The sacred groves have important conservation values. For example, the Garo and the Khasi tribes of northeastern India completely prohibit any human interference in the sacred groves. In other sacred groves, deadwood or dried leaves may be picked up, but the live tree or its branches are never cut. For example, the Gonds of central India prohibit the cutting of a tree but allow fallen parts such as twigs, foliage and fruits to be used by human beings. The socio-cultural and environmental values of sacred groves are immense. This concept keeps people united in all occasions and the environment protected. The concept is prevalent now in ancient communities throughout India. In brief a sacred grove is any grove of trees of special socio-religious importance to a particular culture/community.

Figure 1. Kalpeswar Sacred Grove in Sambalpur district of Odisha. People tie a red cloth, offer fruits, milk products to the deity (Shiva Lingam) and ring the bell wishing god's blessings for specific work. They protect the grove, and the fresh water pond.

Sacred Groves in the world

Sacred groves were most prominent in the ancient Near East, and in India but feature in various cultures throughout the world. Sacred groves were important features of the mythological landscape and cult practice of Greek, Baltic, Celtic, Germanic, Near Eastern, Roman, and Slavic polytheism. They were also used in India, (Temple groves in Ancient India, sacred groves of ancient sages), Japan, and West Africa. Examples of sacred groves in Europe include the Greco-Roman temenos,

the Norse hörgr, and the Celtic nemeton, which was largely but not exclusively associated with Druidic practice. There was a common practice of building churches on the sites of sacred groves. Ancient holy trees still exist in the countryside of England and are mentioned often in folklore and fairytales. There are two mentions on this tradition in the Bible: Abraham planted a grove in Beersheba, and called there the name of God.-Genesis 21:33.

Classification of Sacred Groves

In India sacred groves are usually classified under three categories:

(i) **Traditional Sacred Groves** - It is the place where the village deity resides, who is represented by a symbol.

(ii) **Temple Groves** - a grove is created around a temple and conserved.

(iii) **Cremation Ground Groves** - groves around the burial or cremation grounds of villages.

Table 1. State-wise distribution of sacred groves in India

State	Number of Sacred Groves	Names of Important Sacred groves
Arunachal Pradesh	65	*Gumpa* Forests (Sacred Groves attached to Buddhist monastries)
Andhra Pradesh (Simandhra & Telengana)	750	
Assam	40	Madaico, Than
Chhattisgarh	600	Sarna, Devlas, Mandar, Budhadev
Gujarat	29	
Haryana	248	
Himachal Pradesh	5,000	*Deo Bhumi*
Jharkhand	21	Sarana
Karnataka	1424	*Devara Kadu*
Kerala	2000	Kavus
Madhya Pradesh	21	*Devkot, Matikot, Devsthali, Budhadev*
Maharashtra	1600	Devrais
Manipur	365	*Gamkhap, Mauhak* (sacred bamboo reserves)
Meghalaya	83	*Law Lyngdhoh*
Odisha	322*	*Jahera, Thakuramma* Ravishankar, Nrusinghnath, Kapilas, Tara-Tarini, Andhari, Kalpeswar
Pondicherry	108	*Kovil Kadu*
Rajasthan	09	*Orans, Kenkris, Jogmaya*
Sikkim	56	*Gumpa* Forests
Tamilnadu	503	*Kovil Kadu*
Uttaranchal	18	*Deo Bhumi, Bugyal* (sacred alpine meadows)
West Bengal	670	*Garamthan, Harithan, Jahera, Sabitrithan, Santalburithan*

322* in similiguda, Koraput district, 81 in Sundergarh district, 20 in Sambalpur and Jharsuguda districts. Detail data from other districts not available.

However the sacred grove of 'Nrusingnath' of Bolangir district, Harishankar of Bargarh district, 'Kapilas' of Denkanal district, Tara-Tarini grove of Ganjam district are well known throughout Odisha.

Sacred Groves in Odisha

Table 2 gives the sacred groves of few districts of Odisha.This list is in addition to the already listed sacred groves in Table 1. The table lists the name of the sacred grove, the dominant plant; the tribe/community worships the deity and the name of the deity.

Table 2. Sacred groves (SG) in some districts of Odisha

Sl. No.	Name of SG	District	Approx. Area	Dominant plant species	Management pattern	Tribal group	Deities
1	Medha	Sundergarh	23ha	*Shorea robusta* Roth	Temple trust	Dehri, Munda	Shiva
2	Papanga	Bargarh	200ha	*Cleistanthus collinus* Roxb.	Temple trust, vana Surakhya Samiti(vss), forest	Gond, Bhil, Bhuyan	Budharaja (Shiva)
3	Andhari	Jharsuguda	1000ha	*Shorea robusta* Roth	vss	Gond	Andhari
4	Dedungri	Sambalpur	30ha	*Pterocarpus marsupium* Roxb.	Village	Gond	Gosein baba (Shiva)
5	Gugarpat	Sambalpur	0.8ha	*Shorea robusta* Roth	Community	Gond	Gugarpaat
6	Pitabali	Bargarh	0.5ha	*Sterbulus asper* Lour.	Community	Gond	Pitabali
7	Demul (lakarma)	Sonepur	0.5ha	*Anogeissus latifolia* (DC.) allich *ex* Guill. & err.	Community	Kandha	Kandrapat
8	Mukteswar	Sambalpur	25ha	*Shorea robusta* Roth	Temple trust, vss	Gond, Dehri	Shiva
9	Kalpeswar	Sambalpur	0.5ha	*Terminalia arjuna* Roxb.	Community	Dehri	Shiva
10	Tabdabahal	Sambalpur	1000ha	*Shorea robusta* Roth	Village, forest	Gond	Ganpaat (Sri Ganesh)
11	Durgeikhol	Bargarh	200ha	*Cleistanthus collinus* oxb.	Village	Gond	Durga
12	Pradhanpat	Deogarh		*Shorea robusta* Roth	Forest	Kandha	Padhanibudhi
13	Rambhadevi	Deogarh	20ha	*Shorea robusta* Roth	Village	Kandha	Rambha Devi
14	Demul (Larasara)	Sambalpur	0.2ha	*Sterbulus asper* Lour.	Community	Gond	Gram Devi
15	Budharaja	Sambalpur	30ha	*Cleistanthus collinus* Roxb.	Vss	Dehri	Budharaja
16	Bendalpat	Bargarh	30ha	*Shorea robusta* Roth	Vss	Gond	Bendalpat
17	Demul (banpali)	Sundargarh	0.5ha	*Butea monosperma* Lam.	Community	Gond	Banpat
18	Bandurga	Sambalpur	2ha	*Shorea robusta* Roth	Vss	Common	Ban Durga
19	Bindhyabasini	Bargarh	0.8ha	*Cleistanthus collinus* Roxb.	Vss	Common	Bindhabasini
20	Punjipathar	Bolangir	200ha	*Cleistanthus collinus* Roxb.	Vss	Gond	Dangarbudha (Shiva)

Note: The deities are lord Shiva or Goddess Durga, although names vary depending upon the locality. The tribes are Gond, Dehri, Munda, Bhil, Bhuyan and common people.

Distribution in India

In India, sacred groves are scattered all over the country, and occur in a variety of places -from scrub forests in the Thar Desert of Rajasthan maintained by the Bishnois, deciduous forests in Easternghats, maintained by local tribes, Odias and Telugus, to rain forests in the Kerala and Karnataka of the Western Ghats. Himachal Pradesh in the North and Kerala in the South are specifically known for their large numbers of sacred groves. The Kodavas of Karnataka maintained over large number of sacred groves in Kodagu alone. In Odisha, sacred groves are scattered all over the state and many of them are protected by tribes. These groves do not enjoy protection by law, especially by the environmental laws enacted by the Parliament of the country or by any state legislation. Most of these sacred deities are associated with local Hindu gods. Sacred groves of Buddhist and Islamic prayer places are also known. There has been no comprehensive study on the sacred groves of the entire country.

Around 13,270+ sacred groves have so far been reported from all over India, which act as reservoirs of rare flora, and rare fauna, amid rural and even urban settings. Experts believe that the total number of sacred groves in India could be as high as one lakh (100,000).

Ecological Significance

(i) **Biodiversity Conservation -** The sacred groves are important biodiversity Repositories of flora and fauna that have been conserved by local Communities in a sustainable manner. They are often the last refuge of Endemic species/rare species and medicinal plants in the geographical region/ land scape.

(ii) **Recharge of aquifers -** The groves are usually associated with ponds, streams or springs, which help to meet the water requirements of the local communities. These aquatic ecosystems act as ground water rechargers/rain water harvesters. The vegetative cover help making the place cool because of transpiration by the plants and help in the recharging the aquifers.

(iii) **Soil conservation -** The vegetation cover of the sacred groves protect soil from erosion and brings soil stability of the area.

(iv) **Aesthetic, and other Values -** The traditional and temple sacred groves create an aesthetic atmosphere for recreation by the local community and have tourism potential. Sacred groves are also places of social gathering on special occasions, religious gatherings on special occasions (Figure-2) and have social integration values. In recent times, in some areas Vanamahochhav is also organised in these groves.

Figure 2. Religious offerings in Andhari sacred grove in Jharsuguda district, Odisha

(vi) Tool for Environmental Education- The students of the area take advantage of the presence of sacred groves to learn plant taxonomy, faunal associations, spatial and trophic niche segregation of biodiversity, food chain relationships etc.

Threats to the sacred groves

Sacred groves in many parts of our country have been destroyed due to many reasons.

The common threats identified are:

(i) Pressures due to increasing livestock, fuel wood, medicinal herb collection, silting of water resources etc.

(ii) Rapid urbanization and developmental interventions such as roads, electric lines, railways tracks, dams including commercial forestry and encroachment has led to the shrinkage of some of the largest groves in the country.

(iii) Cultural invasion and disappearance of the traditional belief systems, which were fundamental to the concept of sacred groves. These systems and their rituals are now considered mere superstition.

(iv) 'Sanskritisation'- Many groves are suffering due to the transformation of the forms of nature worship into formal temple-idol worship outside the groves, known as 'Sanskritisation'. New Temple(s) and Shrines construction in the sacred groves also destroys groves.

(v) Invasion by exotic weeds such as Eupatorium odoratum, Lantana camara and Prosopis juliflora is a serious threat to some groves.

(vi) Plantation of commercial species of plants including with exotic species.

However, recently steps are being taken to catalogue the existing sacred groves, to carry out research and to conserve them.

Acknowledgement:

Dr. Satyendra Prasad Mishra and Prof. Niranjan Behera of Sambalpur University provided the photographs and data given in Table 2. I wish to thank them profusely.

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GREEN TEA AND ITS BENEFITS

Mrs. Chitrotpala Devadarshini
Dr. Birendra Ku Prusty

Introduction

The tradition of drinking tea to maintain good health goes a long way back. In early Buddhist texts and Chinese manuals on healing herbs, Camellia sinensis (tea plant) has been described as a potent medicinal plant with properties for promoting good health and longevity, as well as keeping the mind alert and sharp and treating many ailments, from indigestion to the common cold. In our modern society, we are learning that there is quite a bit of scientific evidence to support many of these ancient claims. Medical and health care professionals agree that drinking tea has many benefits and is a healthy addition to any diet.

Nutrients

Studies have shown that green tea contains several main components such as : catechins (texture), caffeine (bitterness), theanine (flavor), as well as various vitamins and minerals all of which contribute to its characteristic taste and aroma. Catechin gives green tea its characteristic texture, and as a potent antioxidant, it also fights against the free radicals in the body. Caffeine gives green tea its bitter taste, while increasing alertness, and relieving fatigue. Theanine, an amino acid, gives green tea its characteristic taste and also acts as a mild relaxant. Theanine helps to relieve the jittery effect that caffeine can sometimes produce in sensitive individuals. This makes it a good alternative to coffee which not only contains a higher level of caffeine, but does not contain theanine to regulate the unpleasant physical side effects. Thus green tea contains a well-balanced mix of all these useful ingredients.

The secret of green tea lies in the fact that it is rich in phytochemicals like : catechin and polyphenols, particularly epigallocatechin gallate-(EGCG) The EGCG is a powerful anti-oxidant; besides inhibiting the growth of cancer cells, it kills cancer cells without harming healthy tissues. It has also been effective in lowering LDL (bad cholesterol) level, inhibiting the abnormal formation of blood clot, reduction of platelet aggregation and lipid regulation.

Table -1 :
Chemical composition of green tea leaves

Constituent	Percentage (% of dried leaf)
Polyphenols	37.0
Carbohydrates	25.0
Caffeine	3.5
Prolein	15.0
Aminoacids	4.0
Ugnin	6.5
Organic acids	1.5
Lipids	2.0
Ash	5.0
Chlorophyll	0.5

Types of Tea

All types of tea are beneficial, though research has shown that some types may contain higher levels of certain polyphenols than others. It can be categorized into three types,

depending on the level of oxidation, i.e. green (not oxidized), oolong (partially oxidized) and black (oxidized) tea. Oxidation means exposure to air while drying without any additives during the process. Another form of tea is white tea which is made from newly grown buds and young leaves that have been steamed to inactivate polyphenoloxidation and then dried. For example, the catechin content is higher in green tea than black tea, though black tea contains theaflavins that green tea does not, due to the higher oxidation. Ideally, one would try to consume a variety of tea to reap the unique health benefits of each type.

Health benefits of Green Tea

It has been reported that green tea has amazing healing properties and a good amount of health benefits against a number of diseases such as : altherosclerosis, cancer, parkinsons', alzheimers', diabetes and liver diseases by taking green tea on by daily basis. Apart from the above mentioned benefits against different diseases, the regular intake of green tea has also been reported to lower the total cholesterol, increase HDL content in the blood and promote fat-loss in human body. Studies have shown that green tea extract also has anti-inflammatory activity and anticoagulative properties. Thus it helps in preventing the clot formation inside the blood vessels.

Side Effects of Green Tea

The following are some of the side effects of green tea intake. Generally, pregnant women should be cautious before starting or continuing the use of green tea in their diets as it contains large amount of caffeine. There is no information available regarding the use of green tea by children. Green tea contains a large amount of caffeine, which may cause anemia and other problems in children. The other less serious side effects of taking green tea could be: heartburn, stomach upset, loss of appetite, sleeplessness etc.

Conclusion

For a long time, Japanese people are known for consuming green tea to accompany their cuisine, which relies heavily on seafood. It is said that Japanese people have naturally understood the protective properties of drinking green tea while eating sushi. The anti-bacterial properties of catechins, that is present in green tea, have now been scientifically demonstrated. It has been announced at academic conferences throughout the world that green tea helps to prevent cancer. In the United States, The University of Texas M.D. Anderson Cancer Center is conducting research on the cancer inhibiting properties of green tea's and the results of this research may be revealed in near future. Focusing on the properties of green tea, science is gradually proving the knowledge of our ancestors regarding the medicinal properties of tea.

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A BRIEF HISTORY OF REGIONAL SCIENCE CENTRE BHUBANESWAR

Dr Jayanta Sthanapati

Introduction

Regional Science Centre (RSC), Bhubaneswar, now celebrates its Silver Jubilee. Inaugurated on 18th September 1989, it is the first endeavor in the state of Odisha, to communicate the message of Science to the public through exhibits and activities. The RSC was a joint venture of the Govt. of Odisha and the National Council of Science Museums (NCSM), an autonomous organization functioning under the aegis of the Ministry of Culture, Govt. of India. I was Project Coordinator of RSC from 1982 to 1994. It again came under my control from 2004 to 2008, when I was Director of Birla Industrial and Technological Museum (BITM), Kolkata.

The Beginning

Shri Gangadhar Mahapatra, the then Minister of Education and Youth Services, Govt. of Odisha, while addressing the inaugural function of the 8th Eastern India Science Fair, as a Guest of Honor at BITM, on 26th February 1982, had said that his department would provide all necessary support to BITM or NCSM, if they set up a Science Museum in Odisha. Dr Saroj Ghose, DG NCSM gladly accepted the offer. As a Curator in NCSM (Hqrs), I volunteered to take up the job and he immediately declared me its Project Coordinator.

We began negotiation with the Education Department and they committed to provide Rs. 40 lakh and suitable land to set up a state level science centre. Soon we selected a plot of land measuring 8 acres adjacent to the Regional College of Education, near Acharya Vihar, but it was occupied by unauthorized dwellers. Although there was initial delay in action, some generous IAS officers resolved the issues soon. In this connection the efforts of Shri G C. Patnaik, Dy. Director is worth mentioning Shri S. K. Mahapatra, the then Secretary of Education, took personal interest to release Rs 3 lakh in favour of NCSM in March 1984, as an advance. Further, due to intervention of Shri S.M. Patnaik, then Secretary, General Administration, vacant possession of 8 acres of land was given to NCSM in November 1984. Dr N.P. Das, Reader in Science of SCERT was of great help in those initial years.

Formative Years

From early 1985, the Science Centre project was coordinated by the Department of Science and Technology (DST) of the state. Shri P. Sarkar, then Secreatry and Dr. S. Torasia, Senior Scientist, DST helped us in all possible ways. Prof P. K. Jena, then Director, RRL Bhubaneswar and Prof T. Pradhan, then Director Institute of Physics, guided me on various aspects of the project.

By the end of 1985, I had prepared the master plan of RSC, under the guidance of Dr Ghose. The plan envisaged erection of main building, creation of indoor galleries, development of science park, horticulture plan, exhibition area, picnic corner, guest rooms etc. Shri K.P, Singh Deo, President of NCSM, who used to take keen interest in our activities, approved the plan.

On 1st September 1986, I started work from a temporary shed at site with an education assistant, a junior engineer (civil), a clerk and a horticulture assistant. A curator (mechanical), a team of eight technicians in the trades of fitting, carpentry, welding, electronics and painting, a section officer and a junior stenographer were also appointed soon. A civil engineer from NCSM was deputed to look after construction of the building.

Regional Science Centre has one of the most eye-catching buildings in Bhbaneswar. M/s Bose Brothers Architects had designed the building with four modules, each consisting of two or three floors. A conscious decision was taken to see that the terrain of the location was not effected. However, in the first phase, only two blocks covering a floor area of 3617 sq. mt. were constructed by M/s Engineers' Enterprise, by early 1988.

Inauguration of RSC

Shri Janaki Ballav Patnaik, then Chief Minister of Odisha, inaugurated Regional Science Centre on 18th September 1989 in presence of Smt. Krishna Sahi, Union Minister of State, Dept. of Culture, three MPs from the state, Shri K.P. Singh Deo, Shri Giridhar Gamang and Smt Jayanti Patnaik; many other dignitaries and a large number of school children. The inauguration was also a part of nationwide celebration of Birth Centenary of Pandit Jawaharlal Nehru. During the year, Sachivalaya Marg, the road on which RSC was situated got renamed as Pt Jawaharlal Nehru Marg.

Indoor Galleries

The Centre, since its inauguration has four exhibition halls -one on the first floor of Block-l and other three on three floors of Block-ll. The galleries that occupied these halls from time to time are described hereunder.

The Sun. The main attraction of the centre at the time of inauguration was a unique gallery on The Sun'. With working and participatory 50 exhibits, the gallery explained and elucidated topics related to the Universe, the Sun, the Earth and their bearing on human existence. There were an idol of the Sun God and a replica of the Sun Temple of Konark, created by a renowned stone-sculptor of Bhubaneswar. An interesting audio-visual show called 'Space Odyssey' was also presented in the gallery.

Motion. In 2004, the Sun gallery was replaced by a refurbished gallery of 54 exhibits on 'Motion' that came from RSC Tirupati. The gallery gave a clear concept about motion and its all-pervading presence in the universe. It was inaugurated on December 9, 2004, by Shri R.N. Nanda, then Minister, Science & Technology, Government of Odisha. A new gallery on 'Motion' has now been created to celebrate the Silver Jubilee of RSC. It has exhibits to explain various types of motion, both perceptible and imperceptible to human beings. Concepts of some exhibits of the gallery were adopted from the Sun and old Motion galleries of RSC. Shri Naveen Patnaik, Chief Minister of Odisha, inaugurated the gallery on August 23, 2014.

Mathematics: A new gallery on 'Mathematics' was inaugurated by Shri Naveen Patnaik, Chief Minister of Orissa, on 18th September 2006, coinciding with the 17th Anniversary of RSC. The gallery of 89 exhibits aimed at unraveling the wonderful world of mathematics and its application. It show-cased exhibits based on arithmatic, algebra, trigonometry, number theory, probability theory, topology, calculus, set theory, and so on. A special film on the 'Life and Works of S. Ramanujan is also screened in the gallery.

Fun Science: The gallery exudes fun while spreading science education. Starting with 18 exhibits, at the time of inauguration of the centre, it was enlarged into a large gallery of 65 exhibits by the end of 2008 and renamed as 'Popular Science'. Exhibit topics include themes like gravitation, pendulum, sound, motion, optical illusion, electricity, light, magnetism and mirrors.

Outdoor Expositions

Science Park. The Science Park at RSC, Bhubaneswar was inaugurated by Shri J.B. Patnaik, the then Chief Minister of Odisha, on the occasion of nationwide celebration of the First National Science Day, on 28th February 1987. It surrounded the main building under construction then, and accommodated 28 outdoor hands-on exhibits on motion, weightlessness, conventional and non-conventional energy, optics, sound, oscillation, inertia, and so on. At the time of inauguration of RSC, the Science Park further included 3 aviaries, a mammal corner and a rabbit corner. During next three years 40 more new exhibits were installed in the park. A cacti corner, a picnic spot and a fair ground were developed thereafter. The exhibits, garden and pathways in front of the main building are well maintained. But almost everything lying between the main building and the Prehistoric Life enclave are in dilapidated conditions for many years. This vast run-down area of RSC is an eyesore to every visitor.

Prehistoric Life Park

This is probably the first open air 'light and sound' presentation on the evolution of life on our planet, in the geological time scale, such as, the appearance of reptiles, dinosaurs, birds, mammals , Ice-age mammals, apes and man, which is show-cased through 33 animated replicas and dioramas. The Park was inaugurated on September 17, 2007, on the eve of 18th Anniversary of RSC, by Shri Samir Dey, then Minister, Higher Education, Govt. of Odisha.

Mobile Science Exhibition

Museobus, a mobile science exhibition bus with 24 working and animated exhibits, on the theme 'Light & Sight' was pressed into service by RSC on February 28, 1987. RSC has changed its MSE units many times during last 27 years, namely, Heat & Temperature, Electricity & Magnetism, The Universe, Global Changes. The last two units were developed at RSC. Mobile buses of the centre have so far organized exhibitions in 1535 schools of Odisha by travelling a distance of 71,303 Km.

A special exhibition

RSC had developed an exhibition on 'Life and Works of Pathani Samanta' in 1993. The exhibition used graphics, replicas and working models to portray the life of the great astronomer and exhibit important instruments he designed like, Mana Yantra,

Chakra Yantra, Gola yantra, Golarardha Yantra, Shanku (The Gnomon) etc. The exhibition was subsequently installed at the Pathani Samanta Planetarium (PSP) in Bhubaneswar on 21.8.2004.

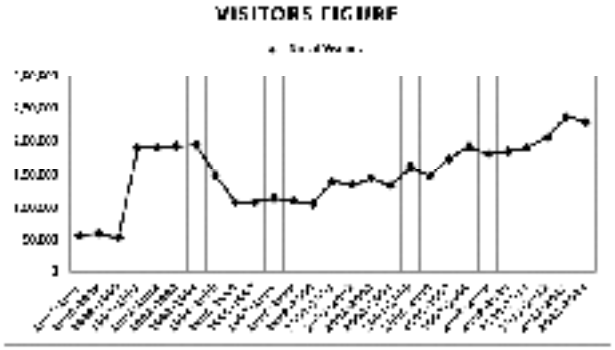
Educational Programmes

The centre organizes various educational programs for general visitors, students and teachers, such as, Sky observation, Taramandal (inflatable dome planetarium) shows, 3D Film shows, Popular Lectures, Science Demonstration Lectures, Public Demonstration Lectures, Science Magic Miracle Shows, Teachers Training Programme, Creative Ability Centre, Science Quiz, Vacation Hobby Programme, Science Seminar, Science Drama, Computer Fair and Commemorative Events.

In addition it has organised many activities in collaboration with PSP including a Telescope Making Workshop and programmes with Orissa Environmental Society.

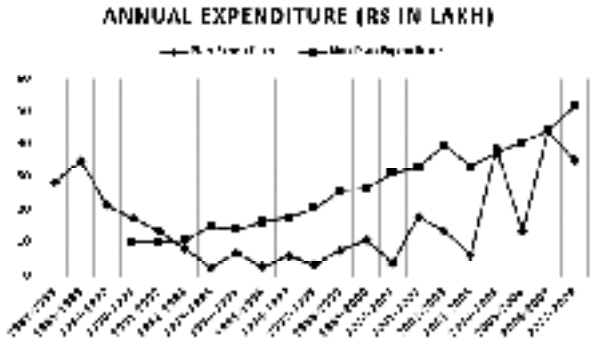
Foot fall of Visitors

RSC received 39,85,166 visitors between 1989-90 and 2013-14, or in other words, it was seen by 1,59,406 visitors per year. The centre had lowest foot fall of 1,06,149 in 1999-2000. Number of visitors in RSC in 1990-91 was 1,90,666 and even after 20 years, in 2010-11 the number remained almost same, 1,90,561. However, population of Bhubaneswar city during the same period had increased 1.9 times - 4,23,465 in 1991 to 8,37,737 in 2011. Is RSC losing popularity ?



Financial Outlay

The centre was completed by NCSM in 1989 at an expenditure of Rs 85 lakh, out of which Rs 40 lakh was contributed by the State Govt. Initially, the project was under Plan for 3 years. The graphs show Plan expenditure (new exhibitions, facilities etc.) and Non-plan



expenditure (salary, electricity, contingency etc.) made by NCSM for RSC from 1990-91 to 2007-08. While non-plan expenses increased every year, plan investment varied greatly. One can possibly observe that decrease in plan allocation had directly affected the visitors' foot fall in RSC.

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WINDBREAKS

Dr. Alok Kumar Patra

Windbreaks are narrow strips of trees, shrubs and/or grass planted to protect crop fields, homes, canals and areas from wind and blowing sand. Regions or places, where wind is a major cause of soil erosion and moisture loss, windbreaks can make a significant contribution to sustainable production. From the farmer's point of view, gentle winds are advantageous as they can contribute to pollination of crops and seed dispersal. Strong winds, on the other hand, are damaging and could be detrimental to agricultural crops, human life and properties.

Major effects of strong winds on crops are:

1. Wind may increase transpiration rate, and this may lead to soil moisture deficits.
2. It can spread pests and diseases because disease causing spores and insects are dropped whenever wind speed is reduced.
3. It can cause crop lodging and deform plants.
4. It can increase loss of topsoil through wind erosion especially in semiarid areas.
5. It can cause drifts during herbicide and insecticide spray, hence leading to wasteful application and ecotoxicity,

Benefits from windbreaks

1. It protects crops and pastures from hot dry wind, cold wind and frost.
2. It reduces/prevents soil erosion.
3. It improves the microclimate by moderating temperature.
4. It reduces evaporation from farmlands, also checks transpiration.
5. It prevents grass fire.
6. It provides fencing and boundary demarcation.
7. It increases overall farm productivity.

Design and Management

The basic design of a windbreak should include permeability, the appropriate orientation, placement, length and height, number of rows, spacing, density and continuity of the wind breakers to provide effective protection.

Permeability : The effectiveness of the windbreak is influenced by its permeability. If it is dense, like a solid wall, the airflow will pass over the top of it and cause turbulence on the leeward side due to the lower pressure on that side. This gives a comparatively limited zone of effective protection on the leeward side compared to the zone that creates a moderately permeable shelter. Ideally windbreaks must be semi-permeable, filtering 50-60 percent of the wind to reduce its strength. The desired permeability can be obtained by carefull selection tree species. Tree species such as Eucalyptus and Casuarina (Jhaun) can form effective windbreakers. Permeability of dense windbreaks can be improved by pruning lower branches at 0.5-0.8 m height from the ground level.

Orientation : While designing a windbreak, the direction of the wind must be considered. A barrier should be established perpendicular to the direction of the prevailing wind for maximum effect. To protect large areas, a number of separate barriers can be created as parts of an overall system. When the prevailing winds are mainly in one direction, a series of parallel shelterbelts perpendicular to that direction should be established. Before establishing windbreaks or shelterbelts, it is important to make a thorough study of the local winds and to plot on a map the direction and strength of the winds.

Height and length : While selecting plant species for their use as windbreakers more emphasis should be given to the height than the thickness of the tree. It is generally accepted that a windbreak protects an area over a distance up to 3-5 times of its own height on the windward side and up to 20 times of its height on the leeward side. Thus, the species selected should be erect, tall growing, hardy and drought resistant, and should occupy less space as far as possible. Windbreaks are more effective when they stretch without major gaps for distances exceeding 12 times the mature height of the trees.

Tree rows and spacing : In reducing the wind speed, narrow barriers can be as effective as wide ones. Although in theory, one-row barriers should suffice, but in practice three to five rows are always more effective. If a single row windbreak is to be planted, tree species that retain their foliage to the ground and give a fairly dense growth should be selected. Eucalyptus trees are generally unsuitable as single row windbreaks because of their habit of losing the lower branches. The main disadvantage of a single row is that if one tree is lost, gap is created which reduces the efficiency of the entire windbreak. Distance between trees varies with the relative importance of the protective versus productive purposes of the windbreak. Initial spacing of 3 meters between the rows, with trees 1-2 meters apart in the rows is desirable.

Species : In general, tree or shrub species selected for windbreaks should have the characteristics of rapid growth, straight stems, wind firmness, good crown formation, deep tap root system and resistance to drought. Some of the tree genera used for windbreaks are *Cassia* (chakunda/rain tree), *Acacia* (acacia/ mangium), *Casuarina* (jhaun), *Leucaena* (subabul), *Pinus* (pine), *Dalbergia* (sissoo), *Syzygium* (jamu), *Erythrina* (paladhua), *Mangifera* (mango), *Bambusa* (bamboo), etc.

Windbreak for fruit orchards

Fruit orchards when exposed to strong wind usually incur heavy losses. Heavy wind increases the losses of moisture both by increasing transpiration and surface evaporation. The high winds also cause damage to fruit trees by breaking of branches, destruction of blooms and dropping of immature fruits. The growth and yield in

protected orchard is definitely better than the exposed orchard. Hence, establishment of a tall growing windbreak is necessary to protect an orchard. Planting of windbreaks should be done at least two years after planting of fruit trees. The first row of it should be planted 10m away from fruit plants at a close spacing to form a thick screen. The windbreak trees sometimes may compete with the fruit trees for water and nutrient. To prevent this competition, a trench may be dug about 1 m deep and 5 m away from the row of windbreak trees and all the roots of windbreak trees exposed in the trench are to be cut off periodically.

Multipurpose windbreaks

Although planting windbreaks is an investment that takes some land out of production, well designed windbreaks protect the health and productivity of crops enough to make the overall return positive. A multipurpose windbreak is designed to provide multiple functions and/or products, in addition to wind protection. Multiple products from a windbreak can include yields such as fruit, timber, fodder, mulch, wildlife habitat and other economic farm products. Adding multiple functions or products to a windbreak plan can make the installation and management more satisfying and economically viable for the farmer. Multipurpose windbreaks require special care in planning and management to maintain the primary function of wind protection while maximizing the secondary yields. Once the form and position are carefully determined, then multiple functions or products can be added.

Since planting trees for a windbreak involves a long term investment, trees having timber value may also be included. The main drawback of having timber as a secondary yield from a windbreak is that wind damage may lead to the production timber of poor quality. Further, windbreak trees require very little or no pruning, the lack of pruning may reduce timber quality and quantity in certain species that require a lot of pruning for optimal timber production. Planning for timber harvest requires the most careful effort as the entire trees are removed. The planting, harvesting and replanting must be coordinated to avoid the creation of gaps in the tree rows. Integrating timber trees with permanent rows of non-timber windbreak trees will help to maintain the effectiveness of the windbreak.

Nitrogen fixing trees (NFTs) can also be integrated in a multi-row windbreak and pruned regularly to provide a nutrient-rich mulch for crops, or a nutritious fodder to supplement the food of farm animals. Although pruning should be avoided for most windbreak trees, the practice of cutting back NFTs and allowing them to resprout can be integrated with windbreak management. Pruned NFTs are much more susceptible to wind damage if they are allowed to regrow to a large size, but if they are cut regularly and the regrowth kept small they will be effective as a short row. To maintain the windbreak's primary function with this practice, it is essential to prune the NFTs regularly. These species are planted on the most sheltered side of the windbreak. The

important species for this purpose are *Leucaena leucocephala* (subabul), *Sesbania sesban* (dhanicha), *Calliandra calothyrsus* (calliandra), and *Gliricidia septum* (gliricidia).

Guidelines for multipurpose windbreak design

1. The species used should be selected first for their wind tolerance and appropriateness for the site (climate, soils, etc). The products should be a secondary consideration in selecting species.
2. Windbreaks designed for multiple products should comprise of multiple rows. It enables more flexibility in management and harvest of products without compromising wind protection by creating gaps.
3. Trees yielding products such as fruit, food, fodder or mulch should be ideally located in the interior or wind-sheltered rows of the windbreak for maximum protection.
4. A diversity of species should be used to have greater flexibility in management and better resistance from insects or other diseases.

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MEDICAL QUIZ

Dr. G. C. Sahoo

1. HIPPOCRATES, the father of medicine was born in 460 B.C. on the island of -

a) COS b) Corsica
c) Canary d) Caladonia

2. The famous medical quote "I dressed him, and God healed him" originated from-

a) Susrut b) Charak
c) Hippocrates d) Ambrois Pare

3. William Harvey discovered blood circulation in which century?

a) 15th b) 16th
c) 17th d) 18th

4. Stethoscope was invented by-

a) Rene Laennec b) Robert Liston
c) Louis Pasteur d) Joseph Lister

5. The first successful public demonstration of Anaesthesia in 1846 was by

a) James simpson b) Horace Wells
c) Crawford Long d) William Morton

6. William Einthoven, a Dutch physician won Nobel Prize in 1924, for the invention of-

a) EMG b) ENG
c) ECG d) EEC

7. The sound frequency used for ULTRASONOGRAPHY (USG) is between

a) 1 to 5 KHz b) 5 to 10 KHz
c) 10 to 15 KHz d) Above 20 KHz

8. Nobel Prize in Medicine for 1979 was awarded to Godfrey Hounsfield for his invention of

a) MRI b) CT Scan
c) NMR d) PET Scan

9. The first human heart transplantation was done by Christian Bernard in 1967 in-

a) England b) South Africa
c) USA d) France

10. At the young age of 27, Louis Pasteur became professor in-

a) Physics b) Chemistry
c) Medicine d) Microbiology

11. Banting & Best discovered Insulin in 1922 by experimenting with-

a) Guinea Pig b) Rat
c) Rabbit d) Dog

12. The very first Nobel Prize in Medicine was awarded to Emil Von Behring for the discovery of-

a) Diptheria Antitoxin
b) Tetanus antitoxin
c) Polio vaccine
d) Anti Rabies vaccine

13. The first antibiotic against Tuberculosis was discovered by-

a) Alexander Fleming b) Waksman
c) Robert Koch d) Louis Pasteur

14. Hargobind Khurana, an Indo-American Molecular Biologist, got Nobel Prize in Medicine for the discovery of-

a) DNA Model b) Cancer gene
c) Genetic Code d) Mobile gene

15. Break bone fever is otherwise known as-

a) Malaria b) Filaria
c) Kala Azar d) Dengue

16. The human equivalent of Mad Cow Disease is known as-

a) BSE b) CJD
c) KURU d) KFD

17. Nobel Prize in Medicine for discovery of the role of Papilloma Virus in cervix cancer was awarded in the year-

a) 2007 b) 2008
c) 2009 d) 2010

18. The first Medical practioner to be made a peer, who developed the techniques of modern antiseptic surgery was-

a) Joseph Lister b) William Crawford
c) John Hunter d) William Osier

19. Blood group (type) was discovered by-

a) Philip Levine b) Rufus Stetson
c) Robert Good d) Karl Landsteiner

20. Swine Flu is caused by the virus-

a) H_1N_1 b) H_2N_1
c) H_1N_2 d) H_5N_1

ANSWERS

1. (a) 2. (d) 3. (c) 4. (a) 5. (d)
6. (c) 7. (d) 8. (b) 9. (b) 10. (b)
11. (d) 12. (a) 13. (b) 14. (c) 15. (d)
16. (b) 17. (b) 18. (a) 19. (d) 20. (a)

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GUIDELINES FOR CONTRIBUTING ARTICLES FOR THE MAGAZINE

1. "SCIENCE HORIZON" aims at developing the scientific outlook of students as well as the general people and seeks to give them information on scientific developments. It is published as a monthly magazine.
2. The authors desirous of writing and contributing articles to the magazine should first assimilate the ideas of the theme and present it in simple language and popular style.
3. The authors are requested to write clearly on one side of A/4 size paper. The relevant pictures in 4cm X 6 cm size are welcome. Photo copies of manuscripts are not accepted for consideration.
4. Each article will be ordinarily of two to three printed pages in A/4 size papers.
5. The article shall be profusely illustrated with pictures.
6. At the end of the article the author should give the references and suggestions for further reading.
7. The reference of books, journals, sources, ideas and essential points collected by the writer should be mentioned in the bibliography. This will enhance the quality and fidelity of the writing and give the reader an opportunity for making further studies.
8. Matter translated from other languages and illustrations should indicate the original sources otherwise those would not be accepted. The articles which are not selected are not returned to the authors. However, if the author wants, such articles may be collected from our office.
9. As far as practicable the articles should be based on contemporary science and must be easily comprehensible to students at the secondary level.
10. The writers should present difficult concepts of science through stories of everyday life, heart-rendering songs, pictures, satirical cartoons or attractive dramas.
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12. The title of the article should be brief and attractive. Moreover, subtitles may be given in long articles. The writings should be coherent and cohesive.
13. There should not be repetition of specific words. While ensuring the contemporary spirit of the writing, it should reflect some valuable lesson for the society. It is also necessary to avoid mistakes in spelling, language use and factual details.
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