ISASINDIA Newsletter

Vol 22, No. 1 January-March 2022

From Editor's Desk

Happy New Year to all ISAS Members

This year is special as India is celebrating Ajadi ka Amrit Mahotsav with great enthusiasm. On this auspicious occasion Dr. Swapnesh Malhotra has nicely compiled the magnificent contribution of Legendary of Dr. Homi Jehangir Bhabha in establishing India as nuclear state.

The progressive journey of DAE has been expressed through rare photographs in chronological order. Many interesting articles are included. China has claimed the production of Artificial Sun by designing world's 1st power plant that can convert Nuclear Fusion Energy into electricity. Union minister of state Dr. Jitendra Singh has launched Samudrayaan, India's first manned ocean mission, at the National Institute of Ocean Technology in Chennai. Creation of heavy elements created subsequent to neutron star collisions is described in one article. China is now home to the world's first small modular nuclear reactor, 200-megawatt reactor at Shidao Bay is providing power to the grid in Shandong province. Carbon Nanotubes have shown great potential for use in electromagnetic interference shielding, nanocomposite materials and radiation tolerant microelectronic components. Researchers in Poland have created the first-ever positronium image recorded during a Positron emission tomography (PET) scan. Scientists revealed to the world, the first image of our galaxy's supermassive black hole, Sagittarius A, proved one of Einstein's predictions from his theory of gravity. Timely prediction of earthquake can assist in saving valuable human lives, also avoiding huge devastation. Unfortunately till now, occurrence of earthquake is not predictable. A ray of hope is seen as according to one study machine learning and gravity signals could rapidly detect big earthquakes. Chemists Benjamin List and David MacMillan developed 'asymmetric organocatalysis, an easier, greener way to build molecules for which they won the chemistry Nobel Prize.

Dr. Pradeep Kumar
Chief Editor, ISAS Newsletter
and Vice President, ISAS

Message from President, ISAS

I am happy to see that the current issue of ISAS News Letter is ready for release.

The fraternity that leads the activities of ISAS, consists mainly of former and current scientists from DAE, ISRO, along with some senior former functionaries of strategic industries, academic institutions, etc. Naturally, the continuation of the work culture of these greatly successful Indian Institutions, influences the functioning of ISAS.

It is a historic fact that formation of DAE (and a bit latter ISRO evolved from it), and they embarking on their activities, also heralded the growth of High Quality Industries in general and Heavy Industries in particular, which paved the way for excellent industrial infrastructural facilities available in India to promote an all-round Indian National growth and development. And it is always highly inspirational to look back upon the process through which the great saga of Achievements were accomplished.

ISAS is also happy to list out and announce the various prestigious Awards conferred by it upon the doyens of science and technology in India as well as several Indian professional Experts in the field.

For the first time in the history of ISAS, ISAS Awards were conferred upon the Analytical Instrument Manufacturers/Suppliers, as a token of appreciation from the user community towards the yeomen contributions made by the Members of IAAI in developing the Scenario of Analytical Sciences and Technologies in India. These ISAS Awards were conferred upon during the Anacon Exhibition held in Mumbai during March 2022.
This is decided to be a regular feature in association with all ANCON.

We are looking forward to very many more vibrant activities during the times ahead and request the entire ISAS Community to actively participate.

With best wishes and regards.

(Dr. P. P. Chandrachoodan)
President,
ISAS

Contribution of Department of Atomic Energyin the Development of Post-Independence India

Swapnesh Kumar Malhotra
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Shri Swapnesh Malhotra is Ex, Outstanding Scientist, and Head, Public Awareness Division, Department of Atomic Energy. He is Ex Secretary, Atomic Energy Education Society, Mumbai .

Our Founder - Dr. Homi Jehangir Bhabha

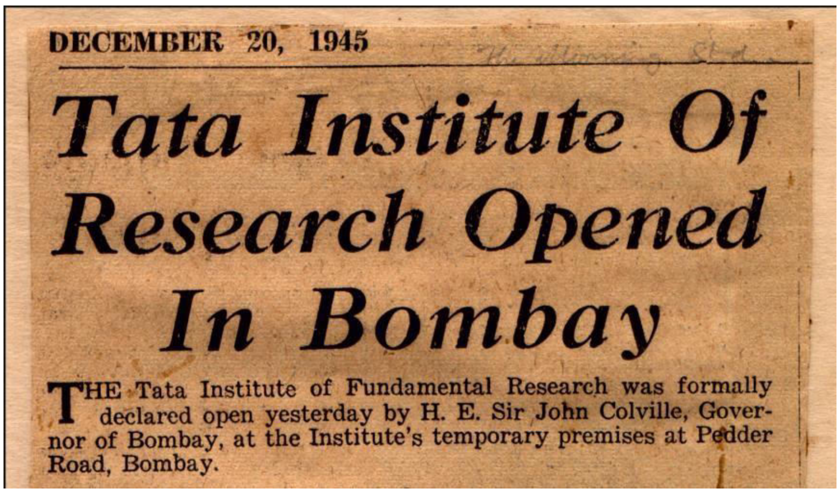
At a time when India was still struggling to free itself from British rule, one Indian had the courage and vision to catapult the country from the 'Bullock Cart' age into the 'Nuclear Era'.

This multidimensional personality was Dr. Homi Jehangir Bhabha, founder of the Atomic Energy Programme in India, whose scientific thoughts, vision and activities led to the creation of a chain of institutesof excellence, addressing a wide spectrum of scientific and societal needs of the country.

Bhabha Stranded in India

Bhabha on a vacation to India in 1939 got stranded because of the World War–II . He joined as reader in theoretical physics at Indian Institute of Science, Bangalore. Somewhere during 1943-44, he started realizing that he ought to do something creative in India rather than returning to England after the war. So in 1944, he wrote a letter to Sir Dorabjee Tata Trust requesting to establish a Centre for Atomic Research in India comparable with other countries.

Birth of the Tata Institute of Fundamental Research



DECEMBER 20, 1945

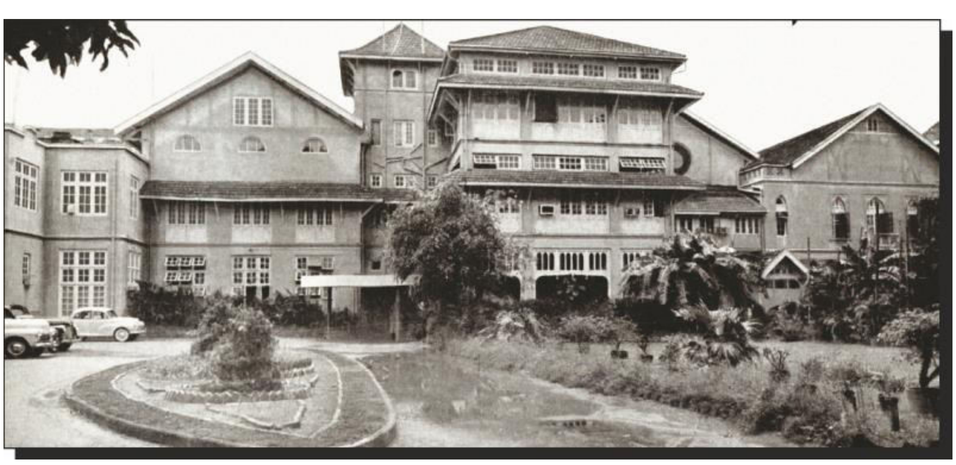
Tata Institute Of Research Opened In Bombay

THE Tata Institute of Fundamental Research was formally declared open yesterday by H. E. Sir John Colville, Governor of Bombay, at the Institute's temporary premises at Pedder Road, Bombay.

Kenilworth Bungalow

The first home of TIFR in Bombay

Dr. Bhabha speaking at theInauguration of TIFR



1949: TIFR moves to the Royal Bombay Yatch Club near the

Gateway of India

1953: TIFR shifts to the World War II barracks, Colaba

1962: The new TI.FR building at Colaba

The Inauguration of TIFR Building by Prime Minister Jwahar Lal Nehru

Besides establishing, it as an outstanding school of research in physics and mathematics, TIFR provided the base for organizing the early efforts of the Atomic Energy Programme of India.

Creation of Atomic Energy Commission and Department of Atomic Energy

- In1945, an Atomic *Research* Committee was set up under the Council of Scientific & Industrial Research.

  In 1947, it was re-constituted as a Board of Research on Atomic Energy, directly under the control of the CSIR. Atomic Energy Act was passed on April 15, 1948.
- •Atomic Energy Commission (AEC) of India was established on August 10, 1948. The Ministry of Atomic Energy was placed directly under the Prime Minister, and Dr. Bhabha was appointed as the Chairman of the AEC.
- •Department of Atomic Energy (DAE) was created on August 3, 1954 with Dr. Bhabha as its first Secretary.

First Research Reactor in Asia

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The Swimming Pool Reactor that had attained first criticality on August 4, 1956, was given the name APSARA on 20th January, 1957 by Pandit Nehru, the then Prime Minister

Asia’s First Nuclear Reactor APSARA

Pure Metallic Uranium!

The decision to build a Uranium Metal Plant was taken in May 1956, its construction was started in December 1957 and thefirst ingot of atomically pure uranium was produced in January 1959. The plant was designed by Indian scientists and engineers and built in about a year.

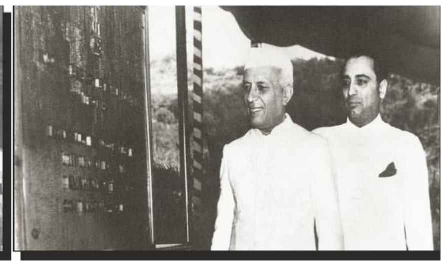
Dr. Bhabha, Shri H. N. Sethna and Col. G. Rajagopala Menon at the Uranium MetalPlant site at Trombay

Prime Minister Pandit Nehru at the Uranium Metal Plant

The First Uranium Metal Ingot from Uranium MetalPlant at Trombay

Atomic Energy Establishment (AEET), Trombay

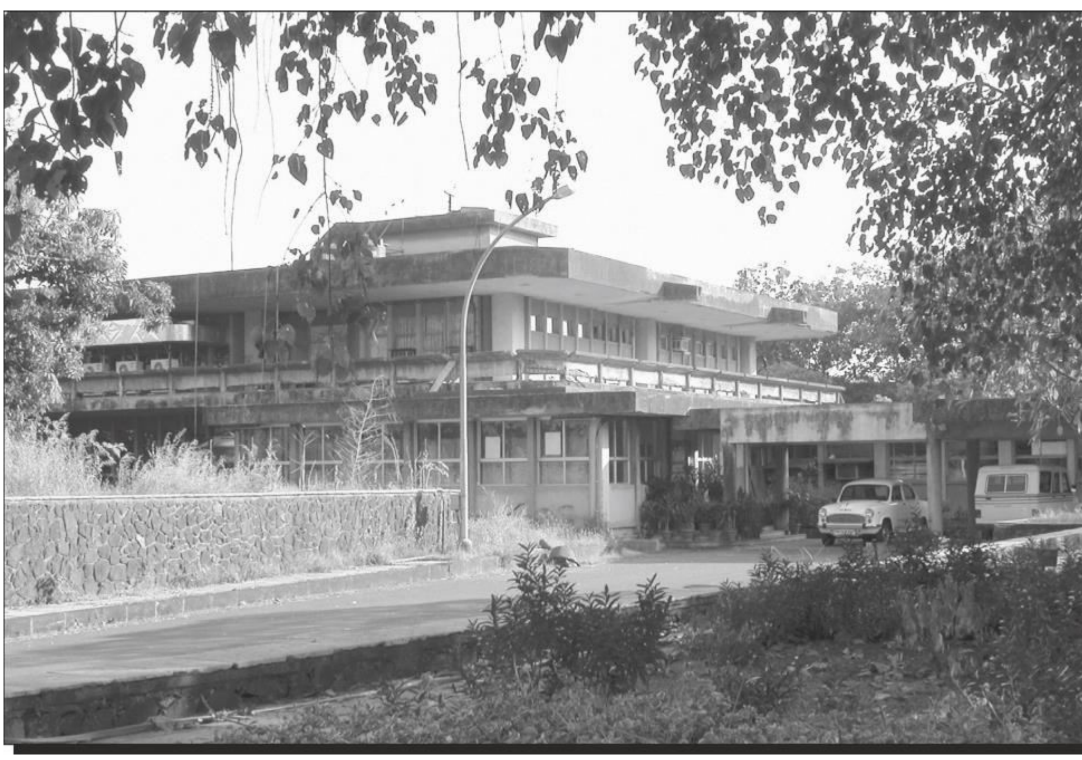
Dr. Bhabha set up a new laboratory called the Atomic EnergyEstablishment, Trombay in a fishing village Turbhe (Trombay).



Dr. Bhabha at the construction Pandit Nehru Inaugurating AEET **Pandit Nehru and Dr. Bhabhaat the**
Inaugural of AEET **Inaugural of AEET**

After the unfortunate demise of Dr. Bhabha,
AEET was renamed as Bhabha Atomic Research Centre and has, over the years developed into apremier research centre not only in India but in the entire world !

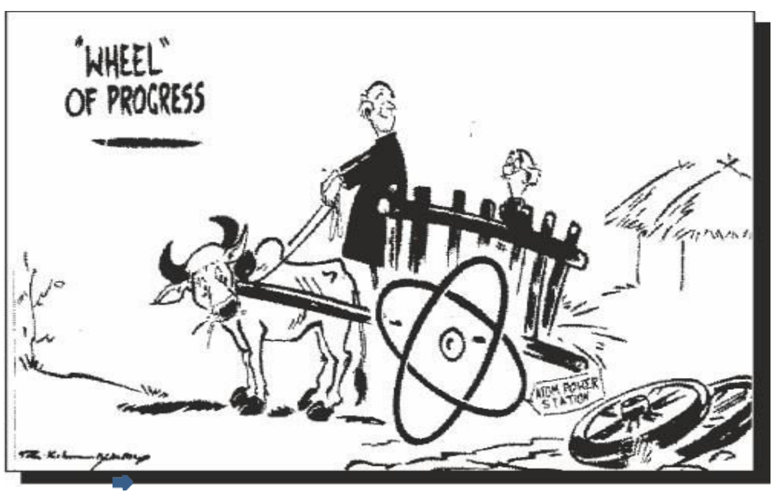
Hire and Train!



The Previous BARC Training School

Dr. Bhabha decided to put fresh graduates through a one-year intensive in-house training, before assigning them to various units of DAE. This was Dr. Bhabha's concept of Hire & Train'. In 1957, a Training School started functioning at AEET to achieve this end.

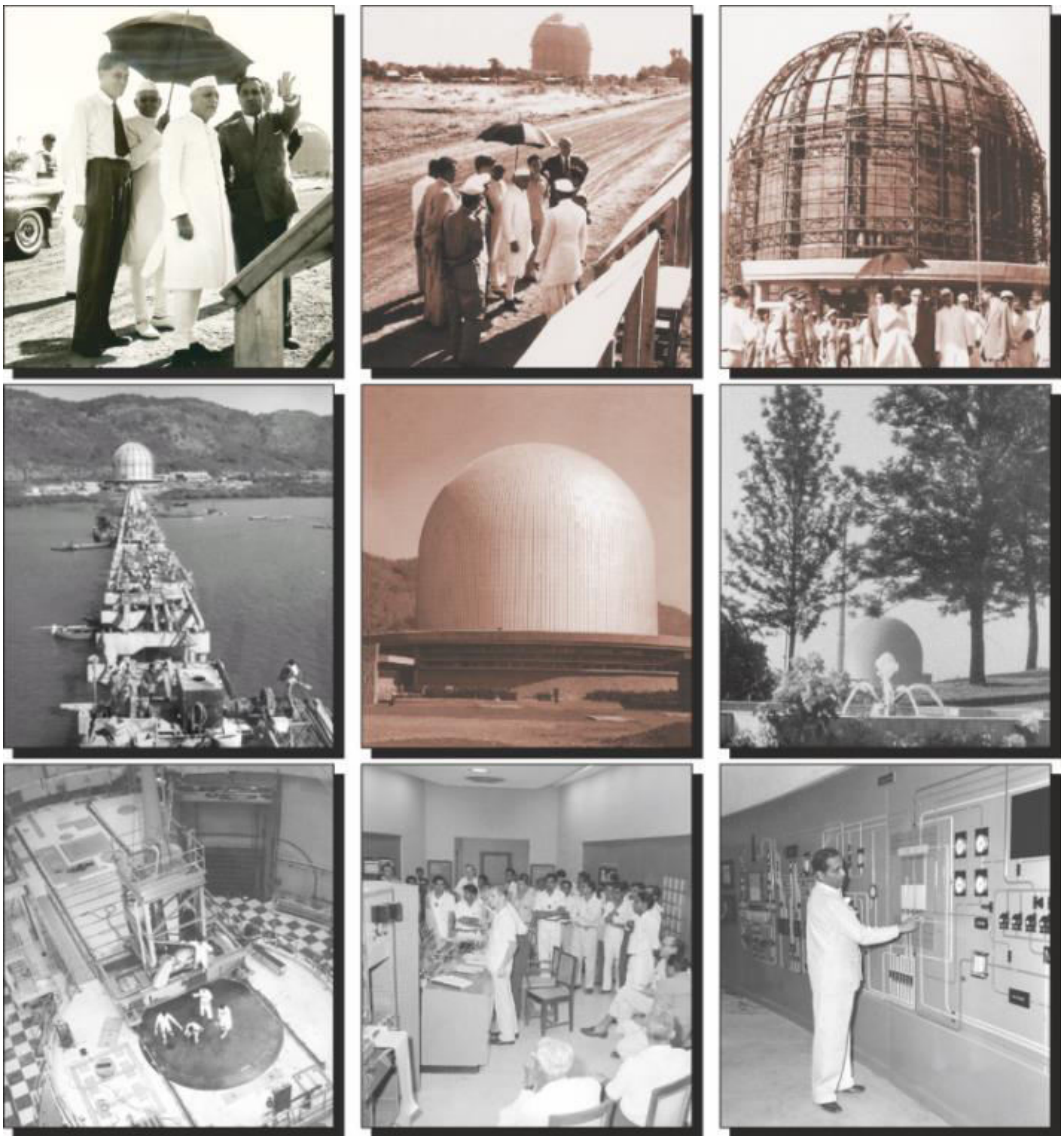
The Present Training School Building, Anushakti Nagar



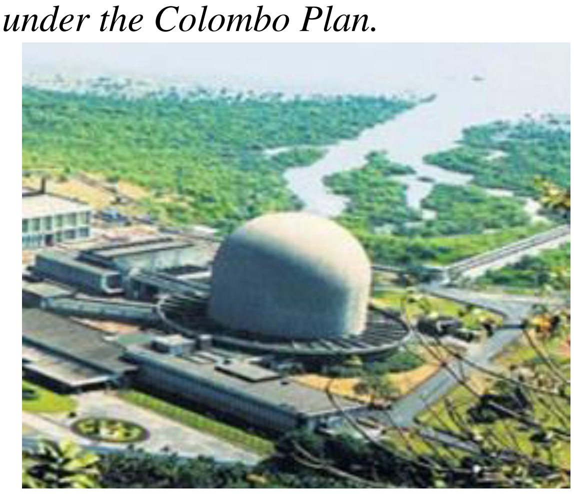
Cartoon by R.K. Laxman showing

India entering the Atomic Age, wheel in bullock cart is replaced by nuclear wheel.

Canada India Reactor : CIR



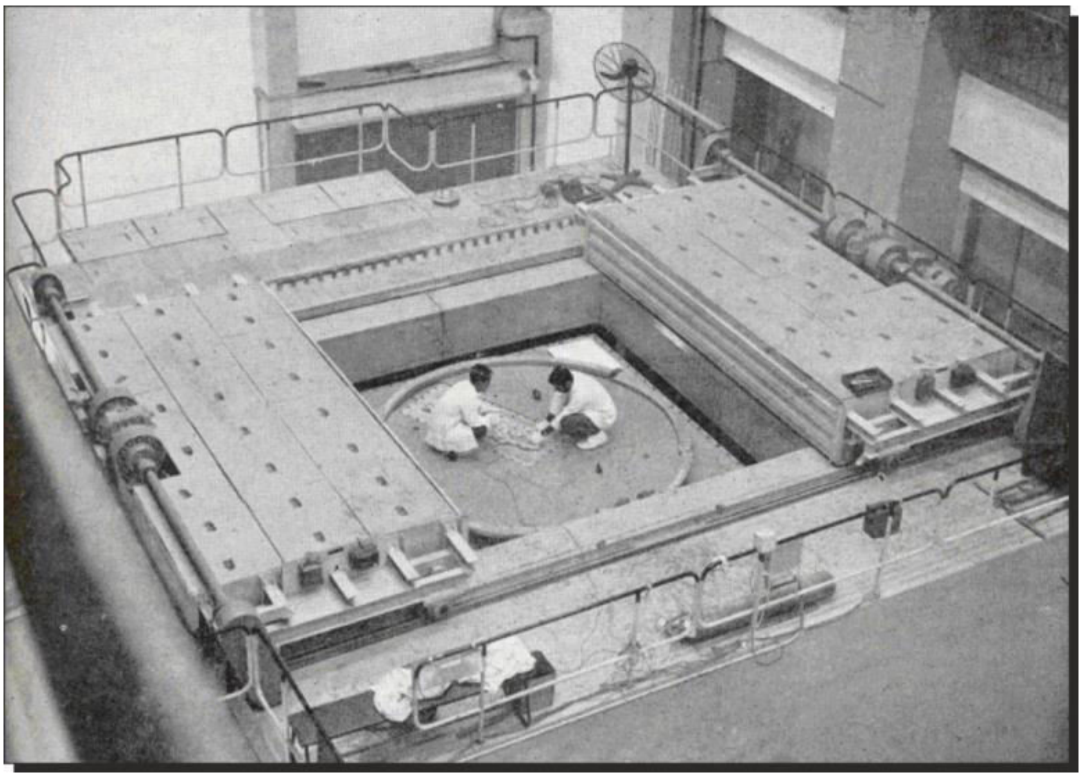
The construction of the 40 MW CIR started in February 1956 and was completed by the first quarter of 1960. Half the cost was borne by India and the other half by Canada under the Colombo Plan.



The reactor was brought to first criticality on July 10, 1960. Later it was given the name-CIRUS. It completed 50 years in July 2010 and was permanently shutdown on December 31, 2010

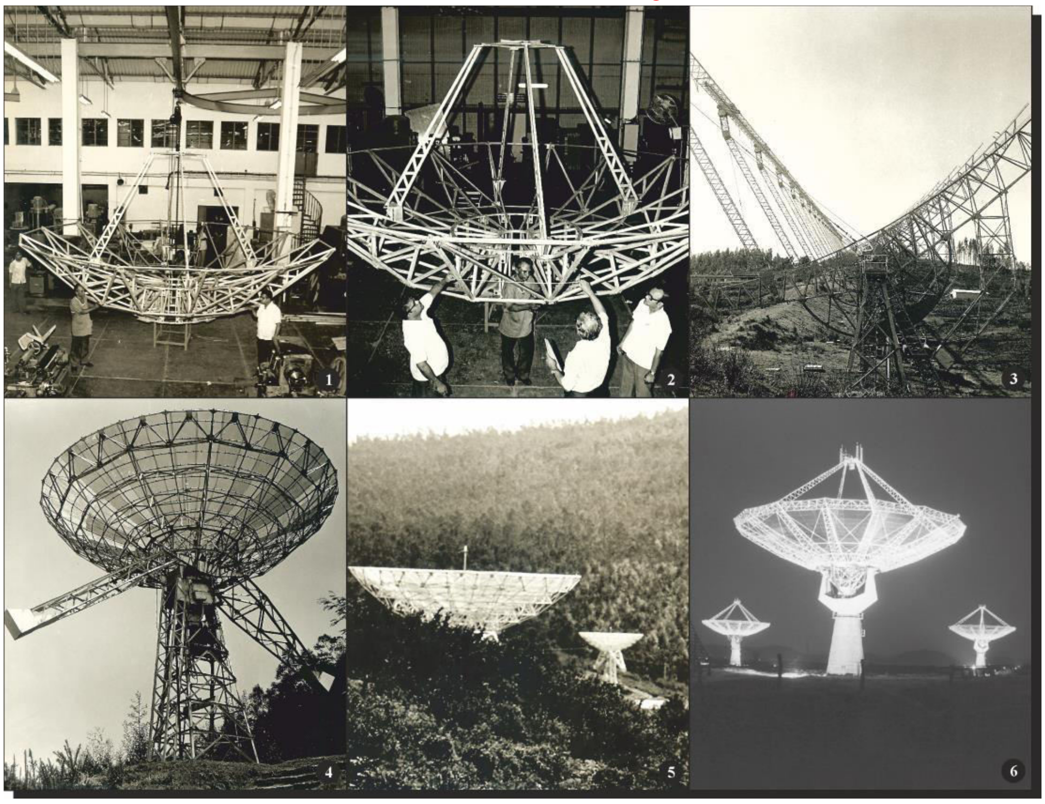
The stepping stone to power reactors

ZERLINA



This reactor was modeled along the lines of the French reactor 'Aquilon'. It was designed to have a variable core permitting a variety of experiments. Zerlina was successfully built and attained criticality on 14 January 1961. It was decommissioned in 1983.

Radio Astronomy

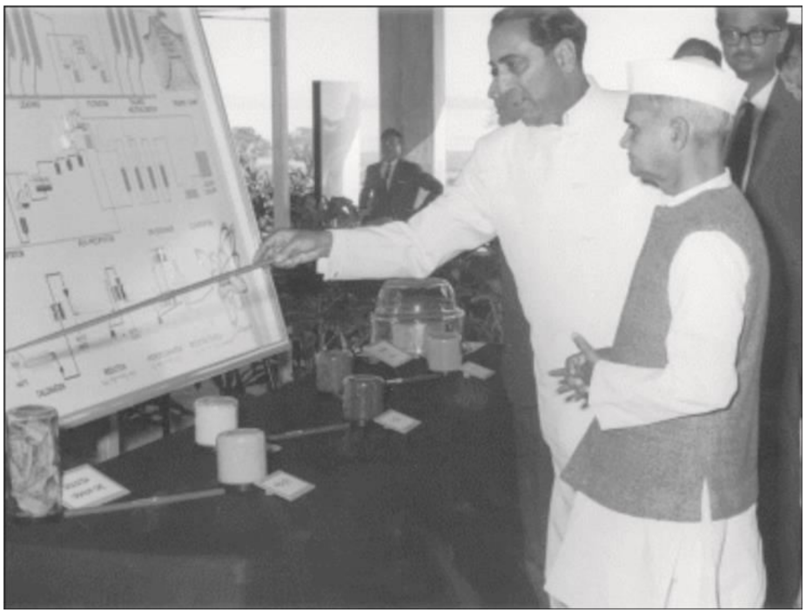


In January 1962 Dr. Bhabha decided to establish a radio astronomy group at TIFR. The result - India’s first indigenously designed and built ‘Ooty Radio Telescope' at Ooty. With this telescope various radio sources in the universe have been investigated.

Much later, a Giant Metrewave Radio Telescope (GMRT), has been built near Pune for studying radio waves. This is the world's largest telescope of its kind.

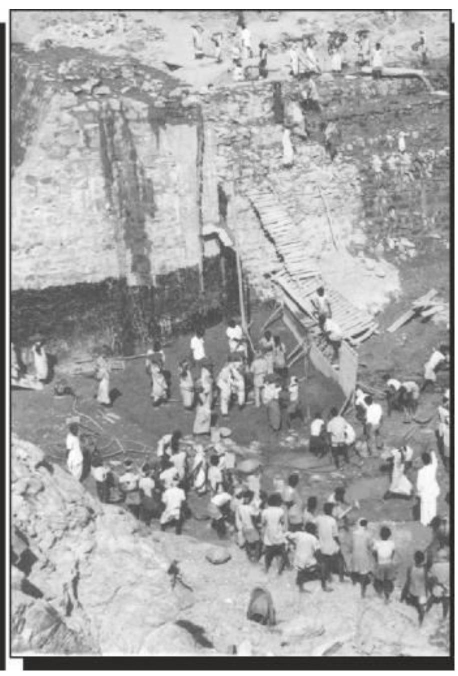
Plutonium Plant

On January 22, 1965, the Plutonium Plant was inaugurated by Shri Lal Bahadur Shastri at the AEET. This was definitely a major leap in technology and a very important step towards closing the nuclear fuel cycle – a philosophy on which the entire Indian Nuclear Power Programme is based.



Uranium Corporation of India Limited

In October 1967, the Uranium Corporation of India (a Public Sector Company) was formed with head quarters at Jaduguda for operating the Uranium Mine and Mill on commercial lines.



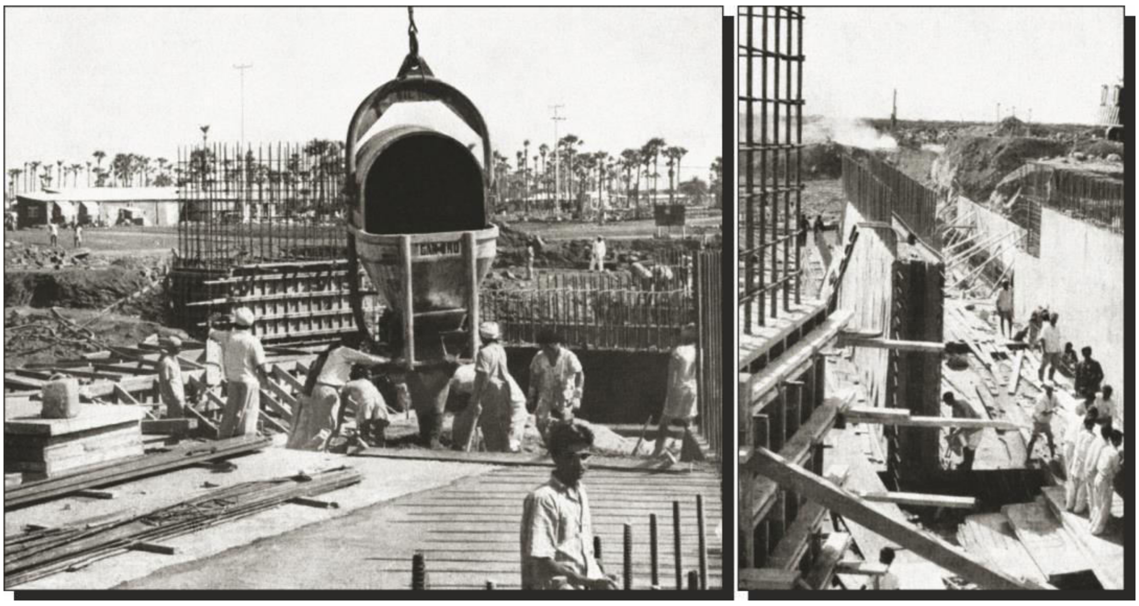
Dr. Bhabha at Jaduguda construction site

Jaduguda Uranium Mill

UCIL Headqauter at Jaduguda

India's First Atomic Power Station

On August 8, 1963, the United States of America and India signed an Agreement for co-operation in the development of atomic energy for peaceful purposes. The Agreement specifically related to the construction of India's first atomic power station at Tarapur, Maharashtra by the General Electric Company of the U.S.A.

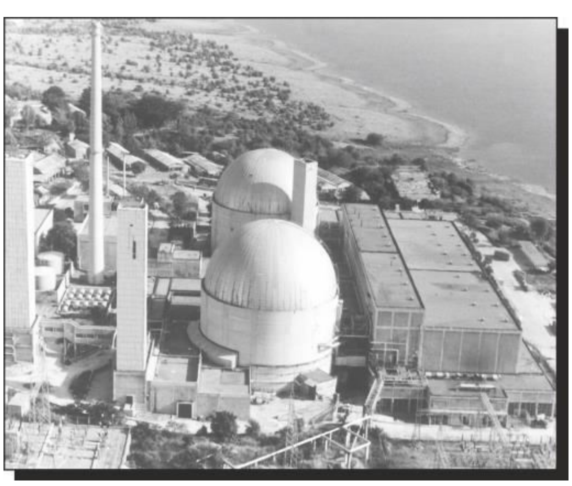


Construction work for TAPS 1&2 in progress

Tarapur Atomic Power Station - Units 1 & 2 (380 MWe) commissioned on October 28, 1969

Rajasthan Atomic Power Station

Under agreements between Canada and India, construction of two PHWRs started at Rana Pratap Sagar , Rawatbhata in Rajasthan



End Shield

RAPS - Units 1 & 2 commissioned on December 16, 1973 & April 1, 1981 respectively

Major Milestones in 1970s

- May 18, 1972 : Research reactor PURNIMA-1 attained criticality. It employed plutonium obtained from the Plutonium Plant by reprocessing the spent fuel from CIRUS.
- May 18, 1974 : India conducted a peaceful underground nuclear experiment (PNE) at Pokharan
- June 16, 1977 : Variable Energy Cyclotron became operational at Kolkata which has since grown into a centre of excellence.
- Two heavy water plants came into operation at Baroda in Gujarat and Tuticorin in Tamilnadu in 1977 and 1978 respectively.

Major Milestones in 1980s

February 19, 1984 : Centre for Advanced Technology (now Raja Ramanna Centre for Advanced Technology), established at Indore.

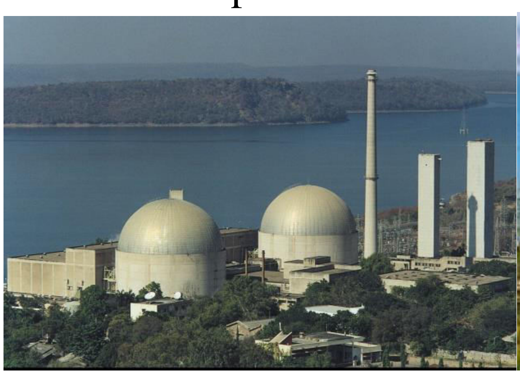
August 8, 1985 : The fully indigenous research reactor **DHRUVA** *attains criticality at BARC.*

October 18, 1985 : Fast Breeder Test Reactor (FBTR) - a 40 MWt fast breeder reactor fuelled with unique Pu-U mixed carbide fuel) attains criticality at the Reactor Research Centre, Kalpakkam (now IGCAR).

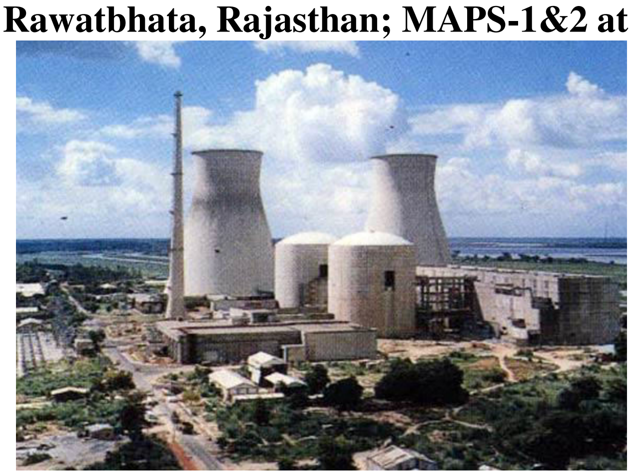
1988 : Board of Radiation and Isotope Technology (BRIT) established with the objective of the benefits of radiation to the society.

October 1986 :Country's second uranium mine at Bhatin in Jharkhand is commissioned.

Four nuclear power reactors were commissioned in the 1980s.

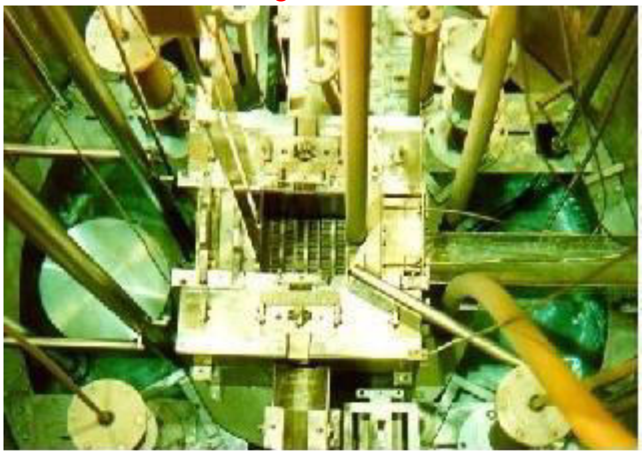


RAPS-2 at Rawatbhata, Rajasthan; MAPS-1&2 at Kalpakkam , Tamilnadu



NAPS-1 at Narora , Uttar Pradesh

Major Milestones in 1990s



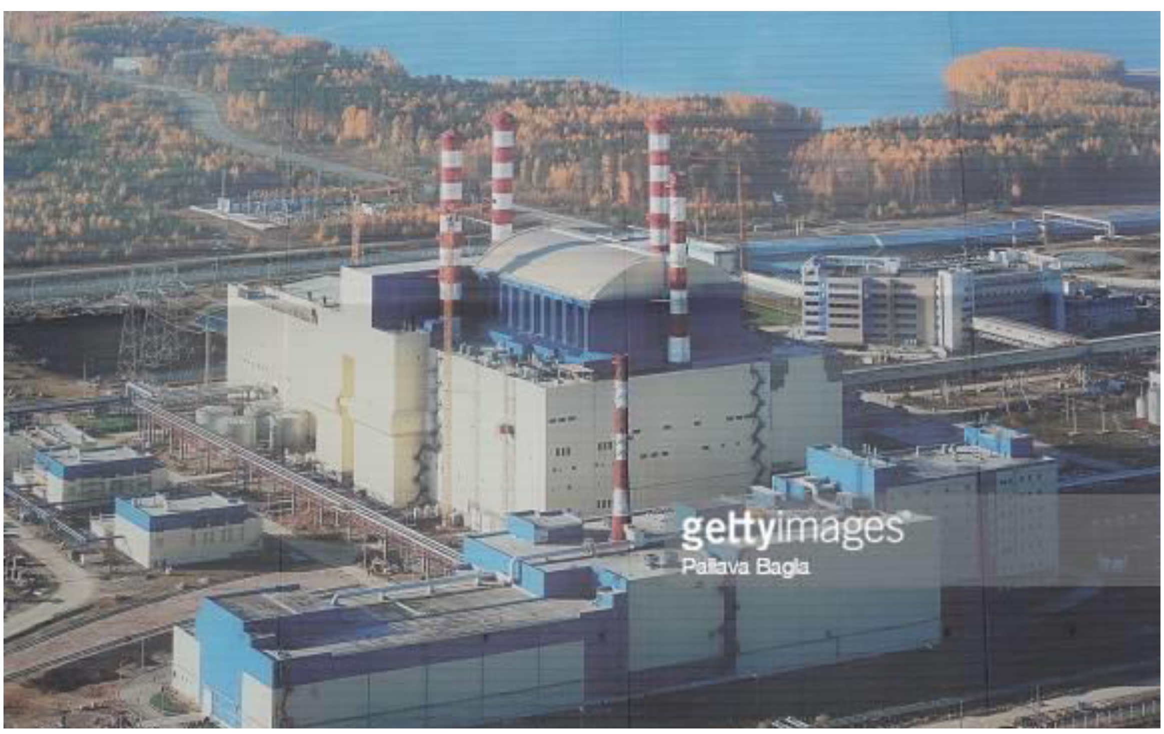
KAMINI with the 233U fuel attains criticality. Kalpakkam becomes the only place in the world where fission of all three fissile materials is taking place at the same time.

PURNIMA–III (a zero energy critical facility employing ^{233}U-Al alloy flat plate type fuel) commissioned at BARC.

Three PHWRs (NAPS-2 at Narora, UP and KAPS 1&2 at Kakrapar, Gujarat commenced commercial operation.

Two Heavy Water Plants, commissioned – one at Hazira in Gujarat and the other at Manuguru in Telangana.

The state-of-the-art uranium mine is commissioned at Narwapahar in Jharkhand. This is the third uranium mine in the country.



Kalpakkam Reprocessing Plant (KARP) starts operating at Kalpakkam in Tamilnadu.

Pokharan -II Nuclear Tests

Crater formed after test 2 on May 11, 1998

India created history by conducting five underground nuclear tests at Pokhran on May 11 and 13, 1998 after which India was declared as a 'Nuclear Power' by Shri Atal Bihari Vajpayee, the then Prime Minister

Nuclear Submarine

India's First Nuclear Powered submarine, ARIHANT, goes critical on August 10, 2013

INDUS-1, a 450 MeV Synchrotron Radiation Source at RRCAT, Indore is commissioned

Two radiation processing plants for commercial demonstration, one with medium dose applications at Vashi, Navi Mumbai 2000

KRUSHAK (Krushi Utpadan Sanrakshan Kendra) for low dose radiation processing of food items at Lasalgaon (2002

Bhartiya Nabhikiya Vidyut Nigam Limited (BHAVINI) was incorporated for design, construction and operation of fast breeder reactors under the second stage of the Indian Nuclear Power Programme.

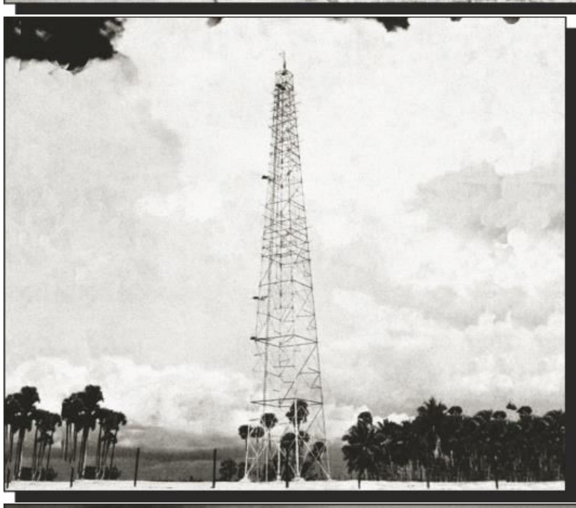
On June 4, 2005 DAE announced setting up of Homi Bhabha National Institute as a Deemed University .

In June 2005, the first indigenous teletherapy machine BHABHTRON-1 developed by BARC for treatment of cancer was installed at the Advanced Centre for Treatment, Research & Education in Cancer (ACTREC).

Indian Space Programme

Dr. Vikram Sarabhai &
Dr. Homi Bhabha

The second stage, Apache, being attached to the first stage, Nike, of the rocket



187-foot high steel tower equipped with instruments for collecting wind data at different heights

The rocket after assembly

Before Department of Space was set up on 1st June 1972, the entire space related activity was carried out under the umbrella of Department of Atomic Energy. Dr. Bhabha and Dr. Sarabhai were the two visionaries who guided the Indian Atomic Energy Programme and the Indian Space Research

Programme in their formative years. On Novembe 21, 1963, with the firing of a two stage Nike-Apache rocket from Thumba, India entered the 'Space Age.'

In September 2007, BARC and ECIL installed the 32 metre diameter Indian Deep Space Antenna System – IDSN 32 for providing steering, tracking and science data reception support for ISRO's Moon Mission, Chandrayaan-1.

On December 17, 2005, INDUS-2 the 2.5 GeV Synchrotron Radiation Source at Centre for Advanced Technology, Indore is dedicated to the Nation and the Centre is renamed as Raja Ramanna Centre for Advanced Technology.

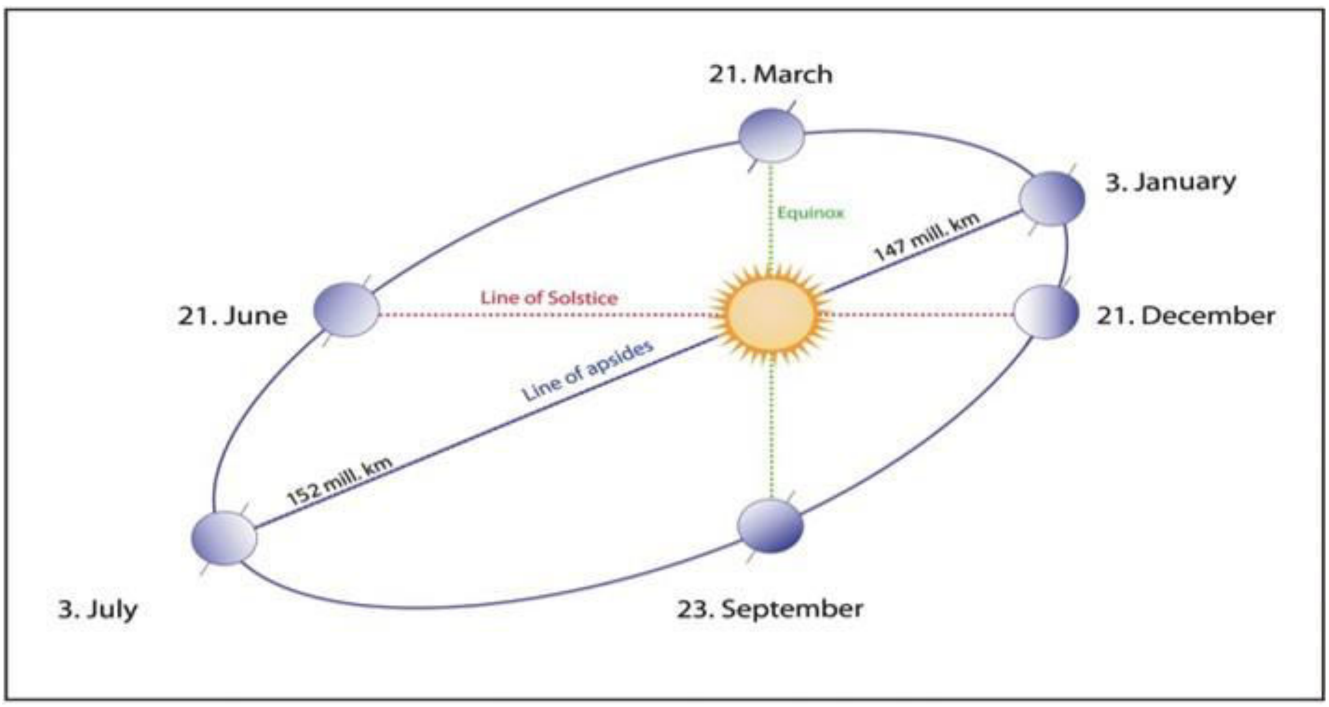
Suryadev and Hanuman Chalisa

Dr. Pradeep Kumar

Senior Scientist at Bhabha Atomic Research Centre, Mumbai

One day I along with my son Ojavi was listening to Hanumal chalisa. One line drew my son's attention. जुग सहस्त्र जोजन पर भानु, लियो ताहि मधुर फल जानु | This line is about story that hanuman tried to swallowed Sun considering it is a shinning fruit. In this lines Tulasi Das tells us the distance of sun from earth. Taking help of internet and available knowledge we tried to calculate the distance between earth and sun. One yug means 12000, shastra means 1000. Regarding yojan, ancient measure of length , is 8 mile means 12.8 Km. In books , various values of yojan are mentioned. The distance of Sun comes out to be 12000x1000x12.8 = 153600000 (or 153.6 million km) .

At present, the accepted value is 151.5 million km). According to modern science the average distance between the Sun and Earth =149 million km.

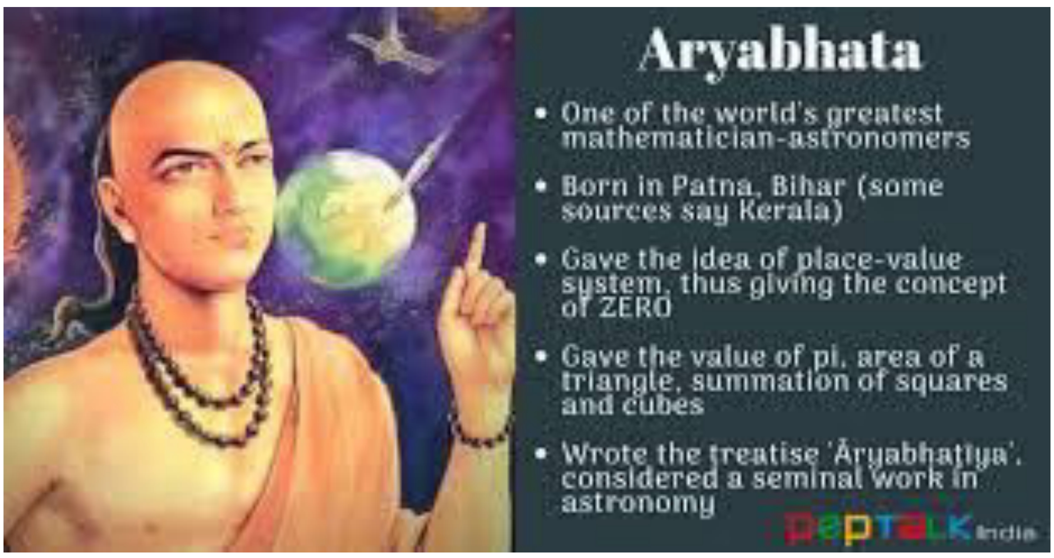


The orbit of earth is elliptical. Shortest distance (perihelion) is 147 million km (early January) and longest distance (aphelion) is 152 million km (early July). The distance stated by Goswami Tulsi Das is in close agreement with the modern value obtained using sophisticated instruments and supercomputers. It is surprise how Tulsi Das Ji had such accurate information without sophisticated instruments. Ramayan was written 7000 years ago.

Arya Bhatt, after whom, India's first satellite was named, predicted the diameter of Earth to be 1050 yojan which amounts to 13440 Km if one yojan is taken as 12.8 km . The modern value is 12742 Km. The Ary Bhatt's prediction is around 5% more than actual value. He calculated the circumference of earth to be 3300 yojan using his predicted value of π (62832/20000 = 3.14160 which amounts to 42240 Km. The value of earth circumference predicted by Arybhatt very near to actual value of 40075 Km. Arybhatt was born on 476 CE. He wrote book aryabhatiya just at the age of 23 years (499 CE).

Bhaskaracharya rightly calculated the time taken by the earth to orbit the sun hundreds of years before the astronomer Smart. His calculations was – Time taken by earth to orbit the sun: (5th century) 365.2588 days. Today's accepted measurement is 365.2564 days. difference of only 0.0002%. Difficult to believe but true.

Thus India had such glorious scientists in the past.



Artificial Sun: China Claims Designing World's 1st Power Plant That can Convert Nuclear Fusion Energy into Electricity

Source website links: https://eurasiantimes.com/artificial-sun-china-claims-designing-worlds-1st-power-plant/

The world's leading powers are investing in nuclear fusion and working to resolve the engineering challenges associated with it. If successful, nuclear fusion can provide nearly limitless energy with minimal waste. China's new announcements indicate that it has taken one step further in that direction. Nuclear fusion is based on the idea that energy can be released by forcing atomic nuclei together rather than separating them, as in the fission reactions that powers the existing nuclear power plants. In what could be a significant breakthrough, a Chinese research team claims to have created the world's first power plant capable of converting fusion energy into electricity without disrupting the power system, South China Morning Post reported. The China Fusion Engineering Test Reactor (CFETR) will produce a massive quantity of heat when it is finished in around 2035, with a peak power output of up to 2 gigawatts. This development comes a few months after China's experimental advanced superconducting Tokamak (EAST), HL-2M fusion energy reactor had run for 1,056 seconds at 70 million degrees Celsius.

An artist's impression of the CFETR (China Fusion Engineering Test Reactor). Credit: Handout

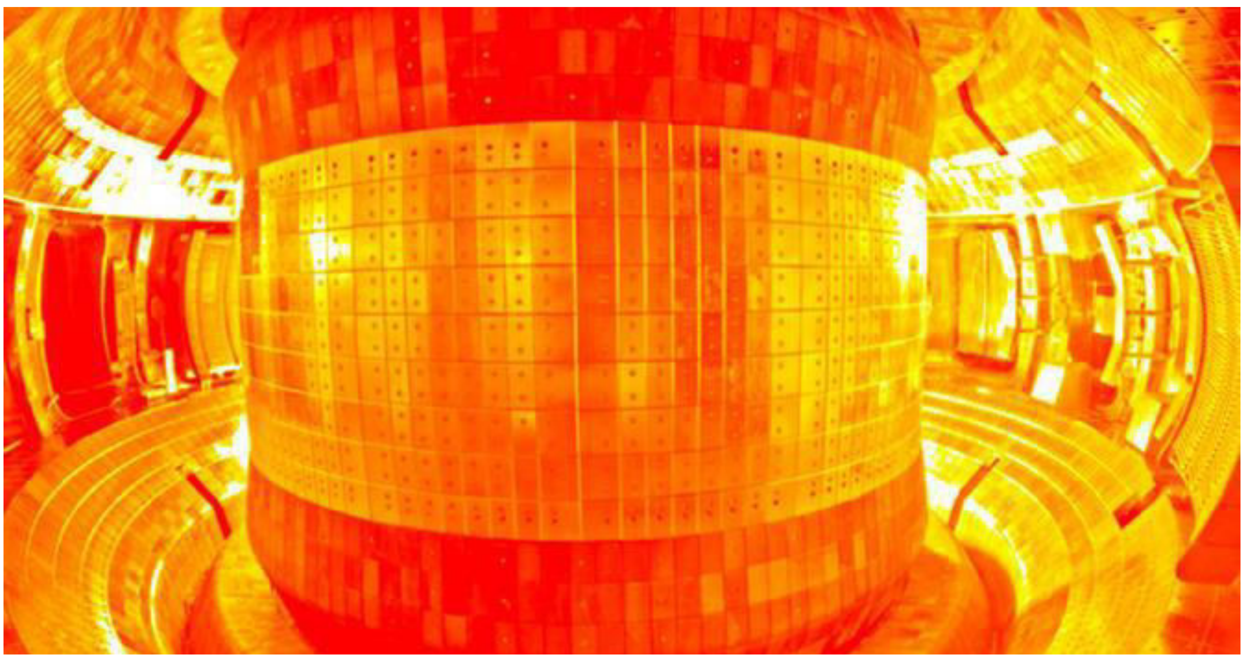
According to Xiang Kui, chief engineer of thermal systems at the China Energy Engineering Group Guangdong Electric Power Design Institute in Guangzhou, converting the heat into electricity is challenging because the reactor must take a 20-minute break every two hours. Xiang and his colleagues stated in a report published in the domestic peer-reviewed journal ‗Southern Energy Construction' that this frequent interruption can create pulse energy that ―will cause huge damage to the power grid.‖

The entire world is chasing nuclear fusion technology, with a facility in France called International Thermonuclear Experimental Reactor (ITER), where experiments take place with the assistance of a world consortium with the EU, the US, Russia, and even China being members.

They hope to make a breakthrough by the second half of this century. At the same time, Chinese researchers have stated that Beijing expects to begin commercial fusion power generation around 2050, but the fusion power plant will require a unique design with a significant buffering zone to safeguard current energy infrastructures from these lethal shocks.Countries like the US and UK are not too far behind in the race. In February this year, the JET laboratory in the United Kingdom broke its world record for the amount of energy it can extract by combining two types of hydrogen. In five seconds, the trials produced 59 megajoules of energy (11 megawatts of power), While all major powers remain committed to ace the technology, there is a long way to overcome engineering challenges associated with creating a perfect operational ‗artificial sun' on Earth.

China's Big Nuclear Fusion Breakthrough Nuclear fusion, a reaction in which two or more atomic nuclei join to form one or more distinct atomic nuclei and subatomic particles (neutrons or protons), produces a lot of energy without producing a lot of waste.

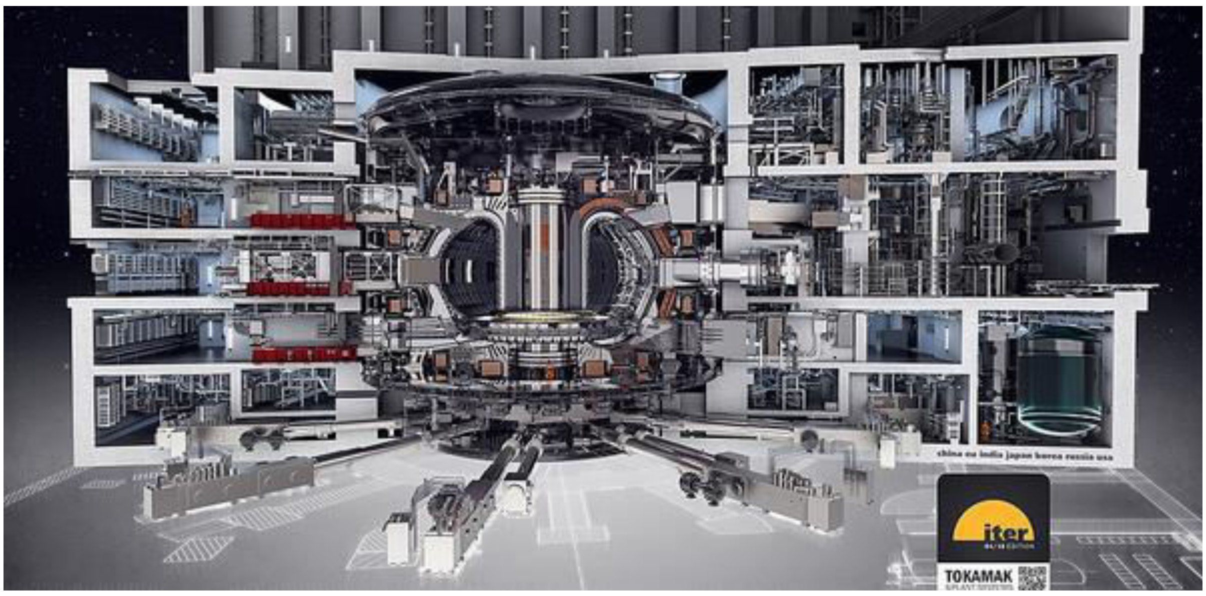
Enormous gravitational pressures in the Sun‘s core allow this to happen at temperatures of roughly 10 million degrees Celsius. To create fusion at a much lower pressure, temperatures must be significantly higher – exceeding 100 million degrees Celsius.There are no materials that can resist such heat in direct contact. To accomplish fusion in a laboratory, scientists created a method in which a super-heated gas, or plasma, is contained inside a doughnut-shaped magnetic field. The doughnut-shaped device is known as the Tokamak.



File Image: Artificial Sun – China

The Chinese CFETR is a Tokamak device that uses fusion energy to generate an extraordinarily powerful magnetic field that can confine and regulate hydrogen gas ten times hotter than the Sun‘s core. When fusion begins, two hydrogen atoms combine into one, releasing a tremendous quantity of energy. However, controlling the heated plasma is tough. So far, the longest run has only lasted two minutes. Based on the rapid advancement of fusion technology in recent years, Chinese experts anticipate that they will be able to prolong the lifespan of stable plasma to several hours in roughly a decade. However, if the plasma becomes unstable, the reactor must be turned off and cooled before another cycle can begin. An ideal fusion reactor would run for months or perhaps years at a time. However, by linking the CFETR to the electrical grid, China will become the first country on Earth to harness the energy of an ―artificial sun.

A heat sink is a solution provided by Xiang‘s team. Helium gas will transmit heat from the fusion reactor to a sink filled with molten salt, according to a conceptual design in their article. The salt temperature will reach 600 degrees Celsius as the total energy in the sink rises. The hot molten salt will then be transferred to a heat exchanger, which will raise water to a boil and power a traditional steam turbine to generate electricity. This method is more advanced than those used in most existing power plants, and some energy will be lost due to the salt-assisted heat exchange. According to Xiang, the heat sink can efficiently prevent pulse energy shocks and connect the fusion reactor to existing power infrastructures. Fusion reactors are thought to be safer than nuclear reactors at the moment because, in the event of an accident, they will immediately shut down and stop the thermonuclear process. They also do notgenerate long-term radioactive waste.



ITER – Wikipedia

The CFETR was launched in 2017 as a follow-up project to the International Thermonuclear Experimental Reactor (ITER), the world‘s first fusion reactor currently being built in southern France. ITER will start up in 2025 and run for up to 10 minutes to demonstrate that the fusion process can generate more energy than it consumes. According to Chinese authorities, the CFETR will go one step further by bridging the gap between scientific experiments and commercial use. While China‘s target could sound somewhat ambitious, and its reported breakthrough is not authenticated, it would be an absolute game-changer if the Chinese researchers could deliver on their promises. A mammoth country like China, with enormous energy needs, would greatly benefit if energy from nuclear fusion is commercialized.

What Is India's Samudrayaan Project? All about the 'Deep Ocean Mission' Launched By Centre

Source website links: https://www.republicworld.com/technology-news/science/what-is-indias-samudrayaan-project-all-about-the-deepocean-mission-launched-by-centre.html

Union Minister of State Dr. Jitendra Singh launched Samudrayaan, India's first manned ocean mission, at the National Institute of Ocean Technology in Chennai.

Union Minister of State Dr Jitendra Singh launched India's first manned ocean mission, Samudrayaan, at the National Institute of Ocean Technology (NIOT) in Chennai on October 29, 2021. With the commencement of the Unique Ocean Mission, India joined the elite group of countries that have specialist technology and vehicles to conduct subsea missions, including the United States, Russia, France, Japan, and China. Samudrayaan Mission will open up greater opportunities for growth in the areas of clean energy, drinking water, and the blue economy.

What is Samudrayaan Mission?

The Samudrayaan mission is India's first manned ocean mission, with the goal of sending men deep into the ocean in a submersible vehicle for deep-ocean exploration and rare mineral mining. The 200-crore Samudrayaan Mission will send three people to a depth of 6000 metres in the sea in a manned submersible vehicle called MATSYA 6000 for deep underwater studies. Submarines havea maximum depth of roughly 200 metres. The Samudrayaan mission was announced by the National Institute of Ocean Technology (NIOT) in tandem with ISRO's Gaganyaan mission, which seeks to launch a manned mission into space by 2022. The Samudrayaan Mission was announced by the NIOT in 2019, with a launch date of 2021-22.

The Rs 6000-crore Samudrayaan mission is part of the Deep Ocean Mission. The Cabinet Committee on Economic Affairs approved the Ministry of Earth Sciences' (MoES) proposal for a "Deep Ocean Mission" on June 16, 2021. The Deep Ocean Mission seeks to investigate the deep ocean for resources, develop deep-sea technology for long-term ocean resource management, and support the Indian government's Blue Economy Initiatives. "Personnel Sphere of 2.1m diameter to be used as a crew module up to 500 m water depth has been developed using mild steel and tested up to 600 m water depth in the Bay of Bengal using the research Vessel Sagar Nidhi during October, 2021," according to Ministry of Earth Science.

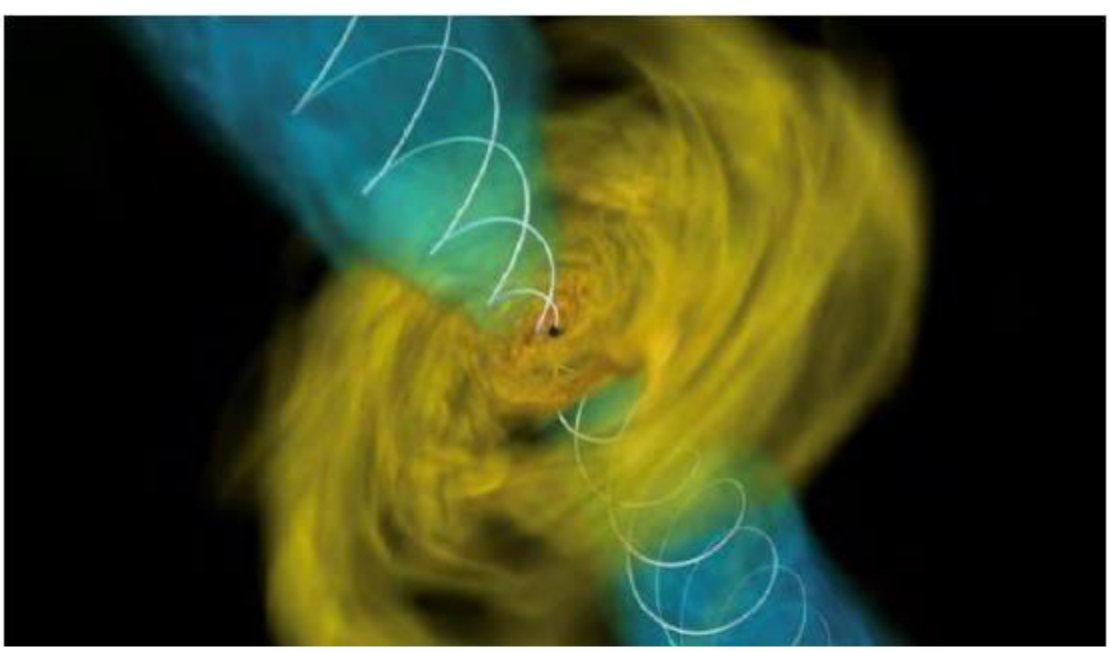
Samudrayaan Mission: Key Points

The Samudrayaan Mission's manned submersible vehicle MATSYA 6000 will help the Ministry of Earth Sciences, MoES, conduct deepocean exploration for resources such as gas hydrates, polymetallic manganese nodules, hydro-thermal sulphides, and cobalt crusts, which are found at depths of 1000 to 5500 metres. Under the Deep Ocean Mission, the National Institute of Ocean Technology (NIOT) and the Ministry of Earth Sciences (MoES) constructed the manned submersible MATSYA 6000 with a depth capacity of 6000 metres. The submersible was designed with 12-hour operational endurance and emergency endurance systems that can last up to 96 hours. The MATSYA 6000 submersible vehicle can crawl for 72 hours on the seabed at a depth of 6 km. At a depth of 6000 metres, the submersible will crawl at the deep bottom with 6-degree freedom utilising a battery-powered propulsion system for 4 hours.

Where Heavy Elements Are Created in the Aftermath of Neutron Star Collisions

Source website links: https://en.brinkwire.com/science/where-heavy-elements-are-created-in-the-aftermath-of-neutron-star-collisions/

Where Heavy Elements Are Made in the Aftermath of Neutron Star Collisions. Nuclear physicists used supercomputers to simulate the extreme state that resulted from the merger of two ultra-dense neutron stars, forming a. Their simulations demonstrated how the leftover matter orbiting the resulting black hole is ejected. The conditions for the creation of the universe's heaviest elements are created by this situation. Astronomers and nuclear physicists have spent decades trying to figure out how and where the universe's heavy elements came from. The collision of neutron stars can create and expel heavy elements, as shown in these computer simulations. These models also show the light flashes that these events cause. Astronomers can use this information to better detect and study these events. The collision of two neutron stars in August 2017 was the first event ever detected in both and light. This occurrence provided scientists with a new window into how matter and gravity behave under extreme conditions. Much of what we know about collisions comes from three-dimensional multi-physics simulations run on the world's fastest supercomputers. Extreme gravity (which necessitates solving Einstein's equations of general relativity) and intense magnetic fields that control matter flow and drive strong turbulence complicate the modeling. The simulations presented here are among the first to look at the long term consequences of a collision in which a disk of leftover matter orbits the newly formed black hole. The simulations demonstrate how magnetic fields in the disk are twisted and amplified, leading to powerful relativistic jets and strong winds.



Almost half of the disk's mass is found to be unbound in this way, and the matter is neutron-rich enough to allow the formation of heavy elements like gold and uranium through a process of rapid neutron capture. The radioactivity of these newly synthesized isotopes will produce a detectable glow, which can be better understood by comparing the new model results to the 2017 event, which was first observed by astronomers. Rodrigo Fernández, Alexander Tchekhovskoy, Eliot Quataert, Francois Foucart, and Daniel Kasen, “Long-term GRMHD simulations of neutron star merger accretion discs: implications for electromagnetic counterparts,” Monthly Notices of the Royal Astronomical Society, 30 October 2018, DOI: 10.1093mnrassty2932.” The US Department of Energy’s Office of Science, Office of Nuclear Physics, contributed to this research. The study made use of the National Energy Research Scientific Computing Center (NERSC), which is funded by the US Department of Energy’s Office of Science. Summary of recent news from Brinkwire.

China Advances in Nuclear Power with World's First Small Modular Nuclear Reactor

Source website links: https://www.wionews.com/world/china-advances-in-nuclear-power-with-worlds-first-small-modular-nuclear-reactor-439228

China is now home to the world's first small modular nuclear reactor. The Huaneng Group Co.’s 200-megawatt unit 1 reactor at Shidao Bay provides power to the grid in Shandong province.

China advances in nuclear power with world's first small modular nuclear reactor Photograph:(Twitter)

The reactor can use nuclear energy for various functions including power generation. It can also be used in the mining sector, industrial parks and for high-end consumption industries. The plant uses helium instead of water to produce power. Its fourth generation reactor shuts down passively in case of any problem. The small module reactors or SMRs, at 200 megawatts are nearly one-fifth the size of Hualong One, which happens to be China's first homegrown reactor design. "SMRs should be less costly to build and operate, faster to implement and have shorter shutdown times during refuelling than traditional nuclear plants," Jefferies analyst Bolor Enkhbaatar said.

The application of SMRs has the ability to drastically cut down the consumption of fossil fuel energy in China. This can further help in promoting energy conservation and carbon emission reduction. A report by Bloomberg reveals that no country in the world is spending on a nuclear plant as much as China. The country is expected to invest $440 billion into new plants in the coming 10 years. China has reportedly built 51 nuclear power units with 19 under construction. It currently has the world's third-largest park of nuclear reactors after the US and France and has invested in developing the nuclear energy sector.

Repelling Radiation with Carbon Nanotubes

Source website links: https://www.azonano.com/article.aspx?ArticleID=5916

Exposure to natural or artificial electromagnetic radiation can harm living organisms as well as sophisticated electronic components.

With the widespread use of electrical and electronic systems in our everyday lives, electromagnetic interference (EMI) shielding becomes essential to protect human health and ensure safe device operation across a broad range of commercial, industrial, and military activities. In that respect, carbon nanotubes (CNTs), owing to their unique electronic properties, have shown a great potential for use in EMI shielding nanocomposite materials and radiation tolerant microelectronic components. Natural background radiation on Earth is inescapable and mostly harmless. However, the levels of radiation exposure originating from human technology are constantly increasing and are considered damaging. Depending on the wavelength, electromagnetic radiation can be divided into gamma rays, X-rays, UV, visible light, infrared, microwave, and radio waves. High-energy electromagnetic radiation, such as gamma rays and X-rays, is also categorized as ionizing radiation, as it causes the formation of charged particles when absorbed in matter.

Technological developments Cause Electromagnetic Pollution

Over the last century, human technology, such as nuclear reactors, medical imaging, wireless telecommunication, space flights, and many others, dramatically increased our exposure to radio waves and, in many cases, to ionizing radiation. The rapid technological

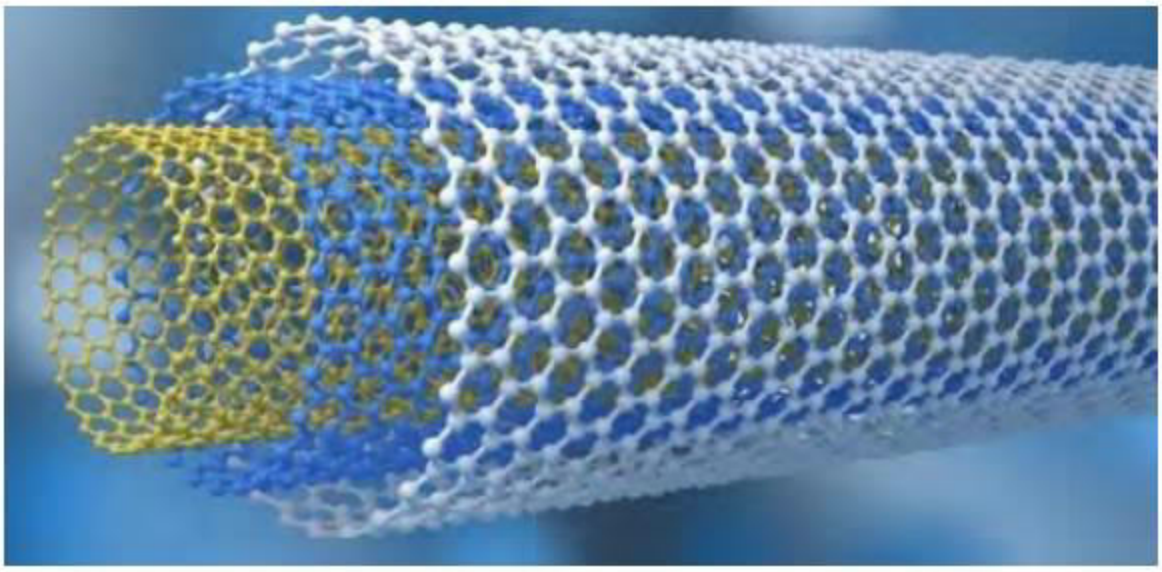


Image Credit: ustas7777777/Shutterstock.com

developments and the resulting electromagnetic pollution instigate concerns not only about the effects of radiation on human health but also regarding the degradation of the performance of a wide range of electronic equipment. Sensors, communication units, remote sensing instruments, computers, transformers, medical devices, and many others, both onboard spacecraft and Earth, can be disturbed or damaged by undesirable EMI.

Graphene: Wonder Material

Effective EMI shielding materials combined with radiation-tolerant electronic components can eliminate the adverse effects of electromagnetic radiation. In the past, metallic materials, such as copper, aluminum, and steel, have been used as effective shielding materials because of their high electrical conductivity and good permeability. However, these materials are disadvantageous in terms of weight and flexibility as many modern applications, like space exploration, wearable electronics, and biomedical sensing, require smaller and lighter devices.

Nanocomposite Materials for EMI Shielding

Polymer nanocomposites that incorporate CNTs have emerged as an alternative to conventional EMI shielding materials due to their remarkable electrical properties, lightweight, and flexibility. Owing to their high specific surface area, the CNTs can effectively form a dense conductive network when dispersed in a polymer matrix, resulting in a highly-conductive material. Structurally similar to graphene, CNTs consist of carbon atoms arranged in a long-range hexagonal lattice of monatomic thickness, which presents a long-range pi-conjugated system (connected porbitals with delocalized electrons).

Such molecular systems are highly tolerant to high-energy radiation since the absorbed energy can spread over the whole system and dissipate rapidly.

Lightweight CNT-Based Materials for Radiation Protection

In the last decade, many research groups have explored the unique properties of the CNT-based nanocomposites and their application as flexible and lightweight radiation shielding materials and fabrics. Besides the ability to absorb and dissipate electromagnetic radiation, such nanocomposites exhibit outstanding mechanical properties and excellent processability. Currently, CNT-based nanocomposites are increasingly used as lead-free X-ray and microwave EMI shielding materials in a wide range of applications, such as spacecraft design, telecommunications, and personal protective equipment for biomedical imaging.

Redesigning the Traditional Semiconductor Devices

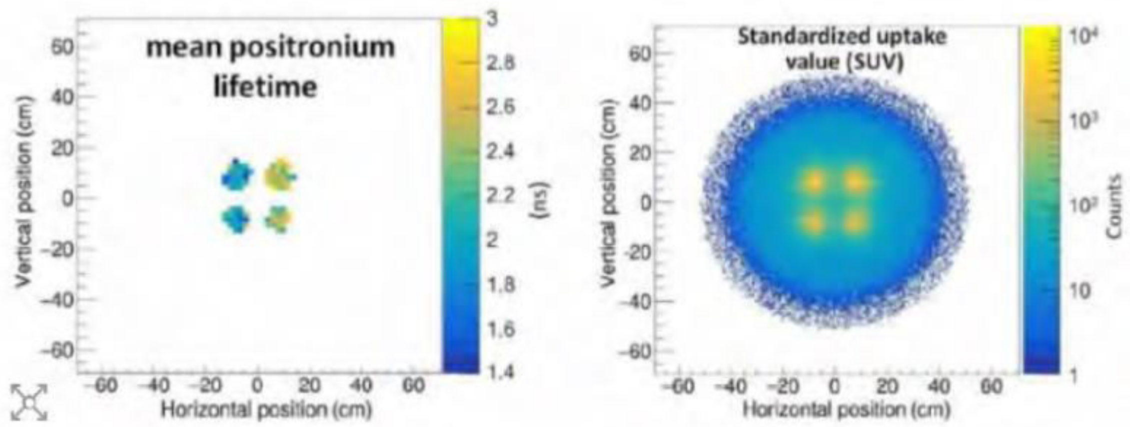
An alternative approach to radiation shielding is to create radiation-tolerant electronic devices capable of withstanding a continuous stream of damaging radiation that can harm or even destroy onboard electronics during a deep-space exploration mission or when operating in nuclear reactors. According to scientists from the Massachusetts Institute of Technology, single-walled CNTs might be the answer to that challenge. With support from the Air Force Research Laboratory in the USA, the researchers built memory chips based on field-effect transistors (FETs), where CNTs deposited on a silicon wafer served as a semiconducting layer.

CNTs Make Transistors More Radiation-Tolerant

By testing different configurations of the CNT-based FETs, the research team is covered that when the semiconducting channel (formed by the CNTs) was complemented by metal gate layers fabricated on top and underneath the entire length of the channel, the novel FETs exhibited stable operation even at extremely high doses of absorbed radiation above 10 Mrad (a significantly higher than the critical dose for the traditional silicon-based electronics). To demonstrate the novel technology's fabrication simplicity and radiation robustness, the research team created static randomaccess memory (SRAM) chips by using the CNT-based FETs. The whole-wafer-sized devices performed similarly to the individual transistors, with a similarly high X-ray radiation threshold. The researchers envisage that the new strategy would enable the realization of FETS and integrated circuits that are much less susceptible to radiation-related damage. The newly developed CNT-based FETs could be a promising route toward next-generation electronics for space exploration and other high level radiation applications.

First Positronium Image Recorded During a PET Scan

Source website links: https://physicsworld.com/a/first-positronium-image-recorded-during-a-pet-scan/



Simultaneous scans: Positronium lifetime image (left) and standardized uptake value image (right) of a phantom containing tumour and adipose tissue samples, recorded using the Jagiellonian-PET scanner. The positronium image reveals differences between cancerous and healthy tissues. (Courtesy: CC BY 4.0/Kamil Dulski, Jagiellonian University)

Positron emission tomography (PET) is a molecular imaging method used for cancer diagnosis. During the imaging procedure, positronium is also generated in the patient‘s body, but current PET systems are not able to acquire positronium images. Now, researchers in Poland have created the first-ever positronium image recorded during a PET scan, reporting their results in Science Advances.

―Our goal in introducing positronium imaging is to increase the specificity of cancer diagnosis such that one can determine the degree of cancer malignancy in vivo without the need for surgical biopsy,‖ explains co-first author and inventor of the positronium imaging Paweł Moskal from Jagiellonian University. ―We believe that the positronium image will enable better distinction between the healthy, cancer and inflammatory tissues and that it will enable us to determine the degree of a tumour‘s malignancy,‖ adds Ewa Stępień, the head of medical research in the group.

During PET scanning, positrons emitted from an injected radionuclide annihilate with electrons in the patient‘s tissue and release a characteristic pair of 511 keV photons. This positron–electron annihilation may proceed directly or, in almost 40% of cases, via the formation of an intermediate positron–electron bound state, known as positronium. Three quarters of the positronium formed is ortho-positronium (o-Ps), which decays into three photons after a mean lifetime (in vacuum) of 142 ns. In tissue, this lifetime is significantly shorter (roughly 1.8 to 4 ns) due to processes such as annihilation of an o-Ps positron with an electron from a surrounding molecule (pickoff) or interaction with oxygen or other biomolecules converting the o-Ps to parapositronium. These pickoff and conversion processes make the mean o-Ps lifetime highly sensitive to the size of inter- and intramolecular voids and the concentration of biomolecules within them. As such, measurements of positronium lifetime may reveal tissue alterations at the molecular level, providing important information about early-stage disease progression.

Triple coincidence

Moskal and colleagues have developed a method for positronium lifetime imaging using the Jagiellonian-PET (J-PET) scanner. The JPET scanner incorporates 192 plastic scintillator strips arranged in concentric layers and read out by photomultipliers connected at both ends. To create a positronium image, the system examines triple coincidence events corresponding to the registration of two annihilation photons and one prompt gamma photon.

―PET scanners are usually designed to register two photons from the positron–electron annihilation,‖ explains co-first author Kamil Dulski. ―The J-PET system is designed for simultaneous registration of both the photons from the annihilation process and photons emitted by the radionuclide.To test the new imaging technique, the researchers created a phantom comprising samples of tumour and adipose tissue excised from two patients. Each of the four samples was inserted into a holder along with a radioactive 22Na source, and inserted into the J-PET tomographic chamber. The 22Na acts as the source of positrons for the experiment, and also emits a 1.27 MeV prompt gamma ray with each decay.

The team used the interaction times and positions of the annihilation photons in the scintillator strips to reconstruct the annihilation rate distribution, which is an analogue of the standardized uptake value (SUV) in a conventional PET image. In this set-up, this SUV image reflects the geometrical configuration of the tissue samples and the activity of the 22Na sources. Next, the researchers reconstructed the prompt gamma emission times, which are near-equivalent to the times of positron emission and positronium formation. For every voxel of the SUV image, they determined the difference between the annihilation time and the time of positron emission. They then used these time difference distributions to determine the mean o-Ps lifetime on a voxel-byvoxel basis, thereby creating a positronium mean lifetime image.

―Reconstruction of the positronium image required development of novel data analysis and image reconstruction methods that enable simultaneous reconstruction of a standard PET metabolic image and the positronium image,‖ notes Dulski. The researchers observed visible and significant differences between the o-Ps lifetime in cancerous and healthy tissues, with mean lifetimes of approximately 1.9 ns in the tumour samples and 2.6 ns in the adipose tissues. This finding suggests that images of positronium mean lifetimes could indeed provide a means for in vivo cancer classification and serve as a virtual biopsy, says Stępień. The next step of the project, says Moskal, will be to construct a high-sensitivity total-body J-PET scanner and perform positronium imaging in vivo. —The J-PET tomography system based on low-cost plastic scintillators enables about five-fold cost reduction [overcrystal-based technology] when building a total-body PET scanner,he tells Physics World. —J-PET technology constitutes a realistic, cost-effective total-body PET solution for broad clinical applications.

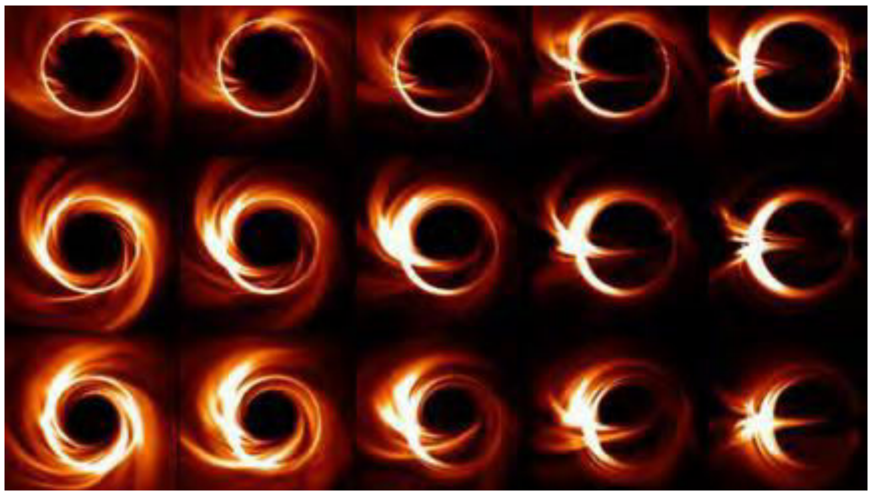
The New Supermassive Black Hole Image just Validated a Key Prediction of Einstein

Source website links: https://interestingengineering.com/supermassive-black-hole-image-prediction-einstein

Wherever we look, we should see donuts".

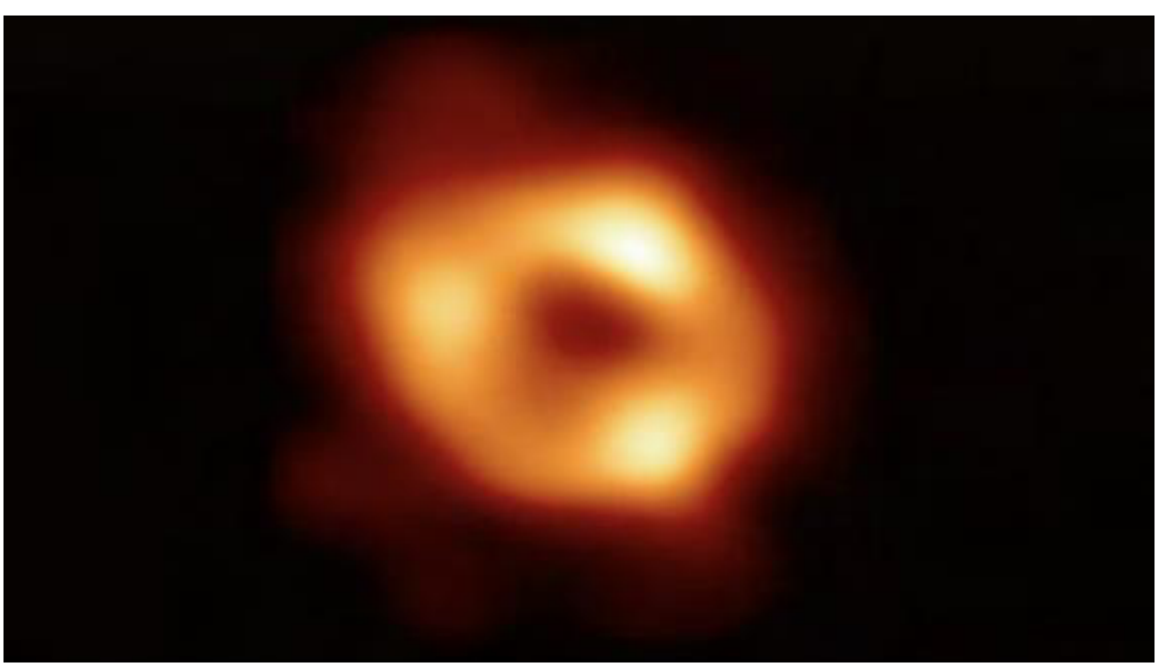
Last week, scientists revealed to the world the first image of our galaxy's supermassive black hole, Sagittarius A. It is the second snapshot of a black hole by the Event Horizon Telescope (EHT) team, which also revealed a picture of MH7 in 2019. One of the leading scientists behind the new breakthrough, Dimitrios Psaltis, professor of astronomy and physics at the University of Arizona, has revealed how the new image proved one of Einstein's predictions from his theory of gravity. It's all down to the striking similarity between Sgr A and MH7, despite their massive difference in size — Sgr A, which has a mass 4 million times greater than that of our Sun, is more than one thousand times smaller than M87.

Black holes defy nature's law of scale. The black hole observations were made thanks to more than 300 international scientists, support personnel, and eight radio observatories worldwide. But they may not have been possible were it not for a groundbreaking paper published in the year 2000 by EHT Science Council members Feryal Özel and Dimitrios Psaltis, both from the University of Arizona, that presented an outline for how to image one of the celestial giants. The new image of Sgr A. has proved one of the most fundamental predictions of Einstein's theory of gravity, Psaltis explained in a statement from the University of Arizona.



Namely, the new data proves that the image of a black hole scales only with its mass. So, in other words, a black hole 1,000 times smaller in mass will look very similar; the only really discernible difference will be the size. "In general, small things typically look very different from big things, and that's no coincidence," Psaltis said. "There is a good reason an ant and an elephant look very different, as one has a lot more mass to support than the other."

This is due to nature's law of scale, which dictates that when two entities are vastly different in size, they usually look very different to one another. Black holes, however, scale while looking very much the same. So, as Psaltis puts it, comparing the new image of Sgr A to the 2019 image of M87 confirms Einstein's theory that black holes appear to be the only objects in existence that only answer to a single law of nature — gravity. "The fact that the light appears like a ring, with the black shadow inside, tells you it's purely gravity," Psaltis said. "It's all predicted by Einstein's theory of general relativity, the only theory in the cosmos that does not care about scale."



The universe is full of almost identical 'donuts'

Now that we can see Sgr A and M87, the EHT team will continue to image and even take videos of black holes in order to gain a better understanding of the cosmic giants and reveal more of their mysterious behaviors to the world. Psaltis says that "wherever we look, we should see donuts, and they all should look more or less the same." "The reason this is important – besides the fact that it confirms our prediction – is that nobody likes it," he continued. "In physics, we tend to dislike a world where things don't have ananchor point, a defined scale."

Machine learning and gravity signals could rapidly detect big earthquakes

Source : Science News, By Carolyn Gramling

May 11, 2022 at 11:00 am

Monitoring speed-of-light changes in Earth's gravitational field could speed up hazard warnings. Massive earthquakes don't just move the ground — they make speed-of-light adjustments to Earth's gravitational field. Now, researchers have trained computers to identify these tiny gravitational signals, demonstrating how the signals can be used to mark the location and size of a strong quake almost instantaneously.

It's a first step to creating a very early warning system for the planet's most powerful quakes, scientists report May 11 in Nature.Such a system could help solve a thorny problem in seismology: how to quickly pin down the true magnitude of a massive quake immediately after it happens, says Andrea Licciardi, a geophysicist at the Université Côte d'Azur in Nice, France. Without that ability, it's much harder to swiftly and effectively issue hazard warnings that could save lives. As large earthquakes rupture, the shaking and shuddering sends seismic waves through the ground that appear as large wiggles on seismometers. But current seismic wave–based detection methods notoriously have difficulty distinguishing between, say, a magnitude 7.5 and magnitude 9 quake in the few seconds following such an event.

That's because the initial estimations of magnitude are based on the height of seismic waves called P waves, which are the first to arrive at monitoring stations. Yet for the strongest quakes, those initial P wave amplitudes max out, making quakes of different magnitudes hard to tell apart. But seismic waves aren't the earliest signs of a quake. All of that mass moving around in a big earthquake also changes the density of the rocks at different locations. Those shifts in density translate to tiny changes in Earth's gravitational field, producing “elastogravity” waves that travel through the ground at the speed of light — even faster than seismic waves.

Such signals were once thought to be too tiny to detect, says seismologist Martin Vallée of the Institut de Physique du Globe de Paris, who was not involved in the new study. Then in 2017, Vallée and his colleagues were the first to report seeing these elastogravity signals in seismic station data. Those findings proved that “you have a window in between the start of the earthquake and the time at which you receive the [seismic] waves,” Vallée says But researchers still pondered over how to turn these elastogravity signals into an effective early warning system. Because gravity wiggles are tiny, they are difficult to distinguish from background noise in seismic data. When scientists looked retroactively, they found that only six mega-earthquakes in the last 30 years have generated identifiable elastogravity signals, including the magnitude 9 Tohoku-Oki earthquake in 2011 that produced a devastating tsunami that flooded two nuclear power plants in Fukushima, Japan (SN: 3/16/11). (A P wave–based initial estimate of that quake’s magnitude was 7.9.)

That’s where computers can come in, Licciardi says. He and his colleagues created PEGSNet, a machine learning network designed to identify “Prompt ElastoGravity Signals.” The researchers trained the machines on a combination of real seismic data collected in Japan and 500,000 simulated gravity signals for earthquakes in the same region. The synthetic gravity data are essential for the training, Licciardi says, because the real data are so scarce, and the machine learning model requires enough input to be able to find patterns in the data. Once trained, the computers were then given a test: Track the origin and evolution of the 2011 Tohoku quake as though it were happening in real time. The result was promising, Licciardi says. The algorithm was able to accurately identify both the magnitude and location of the quake five to 10 seconds earlier than other methods. This study is a proof of concept and hopefully the basis for a prototype of an early warning system, Licciardi says. “Right now, it’s tailored to work … in Japan. We want to build something that can work in other areas” known for powerful quakes, including Chile and Alaska. Eventually, the hope is to build one system that can work globally.

The results show that PEGSNet has the potential to be a powerful tool for early earthquake warnings, particularly when used alongside other earthquake-detection tools, Vallée says. Still, more work needs to be done. For one thing, the algorithm was trained to look for a single point for an earthquake’s origin, which is a reasonable approximation if you’re far away. But close-up, the origin of a quake no longer looks like a point, it’s actually a larger region that has ruptured. If scientists want an accurate estimate of where a rupture happened in the future, the machines need to look for regions, not points, Vallée adds. Bigger advances could come in the future as researchers develop much more sensitive instruments that can detect even tinier quake-caused perturbations to Earth's gravitational field while filtering out other sources of background noise that might obscure the signals. Earth, Vallée says, is a very noisy environment, from its oceans to its atmosphere.

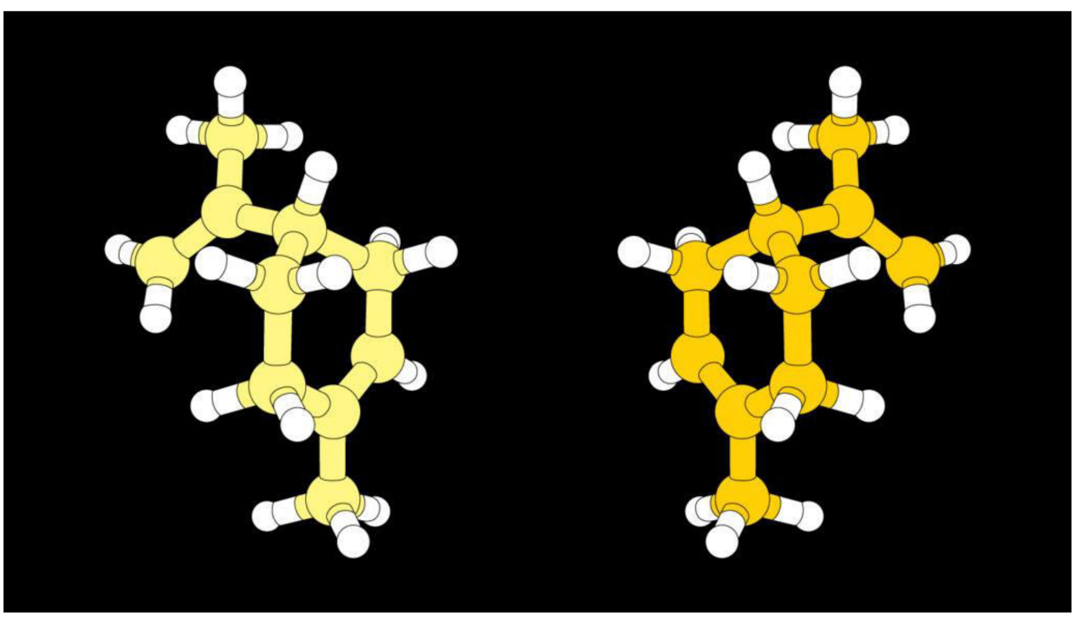
"It's a bit the same as the challenge that physicists face when they try to observe gravitational waves," Vallée says. These ripples in spacetime, triggered by colossal cosmic collisions, are a very different type of gravity-driven wave (SN: 2/11/16). But gravitational wave signals are also dwarfed by Earth's noisiness — in this case, microtremors in the ground.

An easier, greener way to build molecules, wins chemistry Nobel Prize

Source : Science news, By Jonathan Lambert

October 6, 2021 at 11:57 am

Chemists Benjamin List and David MacMillan developed 'asymmetric organocatalysis'



Making molecules is hard work. Atoms must be stitched together into specific arrangements through a series of chemical reactions that are often slow, convoluted and wasteful. The 2021 Nobel Prize in chemistry recognizes two scientists who developed a tool at the turn of the century that revolutionized how chemists construct new molecules, making the process faster and more environmentally friendly.

Chemists Benjamin List of the Max-Planck-Institut für Kohlenforschung in Mülheim an der Ruhr, Germany and David MacMillan of Princeton University were awarded the prize for independently developing organic catalysts that speed up chemical reactions necessary for constructing specific molecules, a process called asymmetric organocatalysis. The two will share the prize of 10 million Swedish kroner (more than $1.1 million), the Royal Swedish Academy of Sciences announced October 6 in a news conference in Stockholm.

“This is a fitting recognition of very important work,” says H.N. Cheng, president of the American Chemical Society.

“We can think of chemists as magicians having magic wands in the lab,” Cheng says. “We wave the wand and a reaction goes on.” These Nobel laureates gave chemists “a new wand,” that’s drastically more efficient and less wasteful, he says.

Making new drugs or designing novel materials often requires building new molecules from simpler chemical building blocks. But these chemical building blocks can’t just be thrown together. Instead, they must be carefully combined in precise arrangements through a series of chemical reactions. Many chemical reactions produce two versions of a molecule that are mirror images of one another, and often those two versions can have very different effects. For example, thalidomide, a drug prescribed in the 1950s and ‘60s for morning sickness, caused birth defects in more than 10,000 babies because of one mirror image of this molecule (SN: 12/24/94). Consequently, building these asymmetric molecules and controlling which version of a molecule gets produced is extremely important, especially for drug development.

Chemical reactions can be coaxed along by catalysts — molecular workhorses that accelerate chemical reactions without being transformed by them. Historically, chemists have known about two kinds of catalysts: enzymes and metal complexes. Enzymes are big, clunky proteins that have been honed by evolution to perform very specific chemical actions in the body, but they can be difficult to use on a large scale in the lab. Metals, such as platinum or cobalt, can kick-start some reactions too, but many only work in airless, waterless environments that are difficult to achieve in manufacturing contexts (SN: 2/21/17). Additionally, many metal catalysts are also toxic to the environment and expensive to procure.

For much of the history of chemistry, these were the only tools available to chemists who wanted to make new molecules. “But in the year 2000, everything changed,” Pernilla Wittung-Stafshede, a chemist at Chalmers University of Technology in Gothenburg, Sweden and a member of the Nobel Committee for Chemistry, said during the news conference.

Benjamin List, then at Scripps Research Institute in La Jolla, Calif., was studying the aldol reaction, which links two molecules together through carbon bonds. In organisms, such reactions are crucial for converting food into energy, and depend on a large and complex enzyme called aldolase A. Only a small part of the enzyme actually catalyzes the reaction, however, and List discovered that a single amino acid — proline — could do the work of this big clunky protein while also producing one version of the final product much more often than the other.

"When I did this experiment, I didn't know what would happen and I thought maybe it's a stupid idea," List said during the news conference. "When I saw it work, I did feel it could be something big."

Unbeknown to List, MacMillan was also looking for alternative organic catalysts around the same time. MacMillan, then at the University of California, Berkeley, focused on another chemical reaction, the Diels-Alder reaction, which forms rings of carbon atoms (SN: 11/18/50). It's an important reaction, used today to make products as different as rubber and pharmaceuticals, but was very slow and relied on finicky metal catalysts that wouldn't work when wet. MacMillan designed small organic molecules that mimicked the catalytic action of metals in a simpler way, while also favoring the production of one of two possible mirror images of the final product. He coined this new kind of catalysis "asymmetric organocatalysis."

List's and MacMillan's discoveries set off an explosion of research into finding more organocatalysts over the next two decades, work that's aided drug discovery among other uses.

About 35 percent of the world's gross domestic product depends on catalysis, Peter Somfai, a chemist at Lund University in Sweden and a member of the Nobel Committee for Chemistry, said during the news conference. "We now have a new powerful tool available for making organic molecules," one that can be drastically more efficient and greener than previous methods.

Somfai highlighted this leap forward in efficiency using the neurotoxin strychnine. The molecule itself isn't useful for chemists, but its complicated structure makes it a good benchmark for comparing different synthesis methodologies. Previously, chemists relied on an extremely wasteful process of 29 different reactions where just 0.0009 percent of the initial material became strychnine. Using organocatalysis, strychnine can now be synthesized in just 12 steps, and the whole process is 7,000 times more efficient, Somfai said. And because this extra efficiency is gained without using toxic metals, organocatalysis is a more environmentally friendly way of synthesizing chemicals.

If building new molecules is like playing chess, organocatalysis has “completely changed the game,” Somfai said. “It’s like adding a new chess piece that can move in different ways.”