Major Scientific Highlights of 2019

The year 2019 witnessed several significant breakthroughs in the field of science and technology. These range from imaging of a black hole for the first time to redefining the Kilogram; first direct evidence of dwarf stars to the confirmation of the first exoplanet and creation of the first living organism with a synthetic DNA to discovery of several new species, and many more. Here are highlights of some of the major interesting scientific accomplishments of the year, along with a special section on Indian S&T developments.

Space Exploration

First-ever Image of a Black Hole Captured

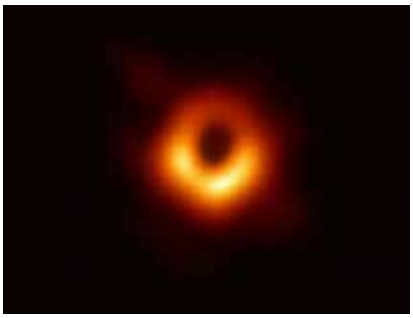


Image Credit: eso.org

A group of global astronomers led by Harvard scientists captured the first ever image of a black hole, so deep and dense that even light cannot escape it. The lopsided ring of the light image surrounds a dark circle deep in the heart-core of a galaxy known as Messier 87 (M87). M87 is considered to be one of the giant galaxies in the constellation Virgo. According to the team of astronomers, the shape of the shadow is circular —a beautiful depiction of a black hole in the centre of M87 with no sign of deviations in general relativity. An international network of radio telescopes called the Event Horizon Telescope (EHT) was used in the study.

First Kuiper Belt Flyby

The National Aeronautics and Space Administration's (NASA) New Horizons mission team released the first detailed information of the farthest world ever explored namely the Kuiper Belt object nicknamed Ultima Thule. Its remarkable appearance highlights the processes that built the planets four and a half billion years ago. Besides the farthest exploration of an object in history which is four billion miles from the Earth, the flyby of Ultima Thule was also the first investigation by any space mission of a well-preserved planetesimal, an ancient relic from the era of planet formation, noted NASA.

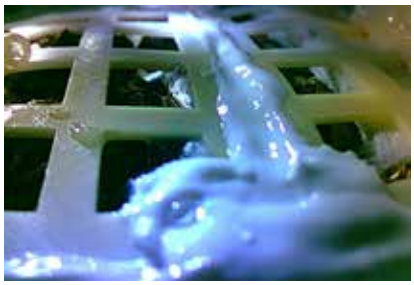
First Direct Evidence of White Dwarf Stars

For the first time, astronomers at the Warwick University found direct evidence of white dwarf stars solidifying into crystals. They also observed that the sky is filled with white dwarf stars, out of which the oldest is almost completely crystallized. White dwarf stars are some of the oldest stellar objects in the universe and are very useful to astronomers as their predictable lifecycle allows them to be used as cosmic clocks to estimate the age of groups of neighbouring stars to a high degree of accuracy. The study was published in *Nature*.

NASA's TESS Unveils New Planetary System

Transiting Exoplanet Survey Satellite (TESS) of NASA discovered a new planetary system comprising three new planets orbiting a nearby dwarf star called TESS Object of Interest (TOI) 270. The newly found planetary system is about 73 light-years away in the Southern Constellation of the Pictor. The dwarf star is 40% smaller than the sun in size and mass both. The new planetary system will enable a better understanding of the formation and evolution of planetary systems. A study describing the system was published in the journal *Nature Astronomy*.

First-ever Plants Sprout on the Moon



Adapted from *Nature* (Wang Quanchao/ Xinhua via Zuma)

Cotton seeds sprouted on the Moon and became the first plants to germinate on the Moon. China soft-landed its Chang'e-4 mission on the far side of the Moon (first craft to softly land on the far side of the Moon on 3 January) with an experimental module on the lander containing a sealed container of seeds, more or less a mini biosphere to support the growth of seeds. However, the little sprouts perished later due to extremely low freezing temperatures during the lunar night.

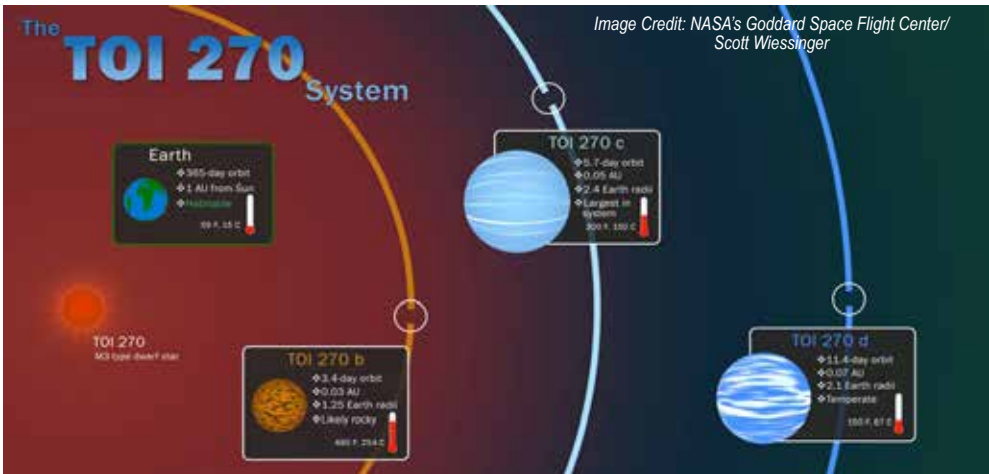


Image Credit: NASA's Goddard Space Flight Center/ Scott Wiessinger

First Nearby Habitable Super-Earth

A team of astronomers at Cornell University has uncovered the first potentially habitable planet outside our solar system using NASA's Transiting Exoplanet Survey Satellite (TESS). The exoplanet is named as GJ 357 d. It is supermassive as compared to earth and located about 31 light-years away. The research has been published in the *Astrophysical Journal Letters*.

Marsquake Detected

Artist's concept of Insight Lander on Mars
[Adapted from mars.nasa.gov (*Image Credit: NASA/JPL-Caltech*)]

NASA's InSight lander on 6 April 2019 for the first time ever detected a seismological tremor on Mars which was recorded as "Marsquake" (The Martian Sol 128) — a natural trembling from the Mars interior. It is the first seismic activity ever recorded on a planetary body outside of the earth or the moon.

NASA's Kepler Confirms First Exoplanet

Ten years ago, despite being the very first exoplanet revealed by NASA's Kepler Space Telescope, Kepler-1658b was marked as a false positive as it was not really pointing to a planet. But in March 2019, new software was used to refine the data and reexamine it, which changed it from a data anomaly to a possible planet. The newly-confirmed Kepler-1658b is a massive hot Jupiter that whips around its star every 3.85 days.

Bedin 1, Dwarf Spheroidal Galaxy Found

Image Credit: Bedin et al./ESA/Hubble/NASA

With the help of the NASA/ESA Hubble Space Telescope, astronomers have found a new dwarf galaxy in our cosmic neighbourhood which has been named as Bedin 1. The newly discovered galaxy is approximately 30 million light-years away and is classified as a dwarf spheroidal galaxy as it measures only around 3,000 light-years at its greatest extent and is roughly a thousand times dimmer than our own Milky Way Galaxy.

"Forbidden Planet" — Neptune Size Exoplanet

Using the state-of-the-art Next-Generation Transit Survey (NGTS) observing facility, an international collaboration of astronomers led by the University of Warwick, UK, discovered a rare sub-Neptune-sized transiting exoplanet. The newly discovered planet formally named as NGTS-4b is 20% smaller than Neptune and about three times the size of the earth orbiting its host star in the harsh conditions of the Neptunian Desert. Due to its rare existence astronomers have nicknamed it as the "Forbidden Planet".

NGTS-4b is 920 light-years away from the earth revolving around the host star in only 1.3 days equivalent to the earth's orbit around the sun in one year. The planet is 1000 degrees Celsius and hotter than Mercury.

K2-288Bb — Discovered in a Low-mass Binary System

NASA's Kepler Space Telescope unveiled a super-earth planet K2-288Bb which is roughly twice the size of Earth orbiting a star in the low-mass binary system K2-288 in the constellation of Taurus about 226 light-years from Earth. The newly discovered world could be rocky or gaseous similar to Neptune. The discovery was reported in *Astronomical Journal*.

Universe's First Molecule Spotted in Space

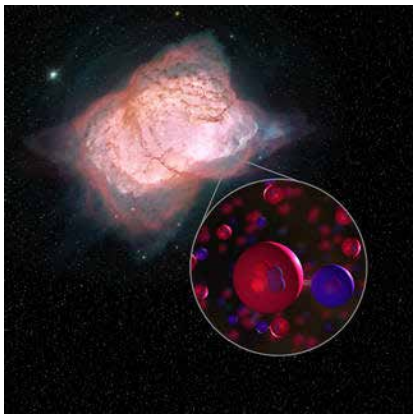
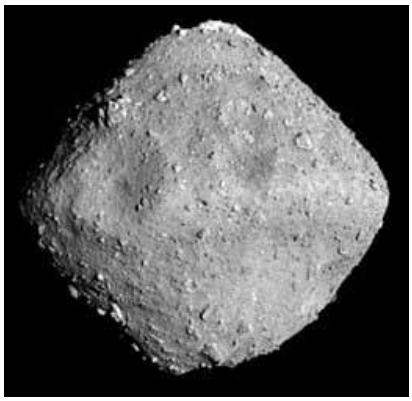


Image Credit: https://www.nasa.gov/

After decades of searching, NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA) detected the first elusive molecule that ever formed in the universe for the first time. The discovered molecule is Helium Hydride (HeH+) on a planetary nebula namely NGC-7027, a remnant of the sun-like star, situated 3,000 light-years away near the constellation Cygnus. The molecule is considered to be formed some 380,000 years after the Big Bang and is regarded as the first molecular bond. The discovery was published in *Nature*.

Hayabusa 2 Performs Second Touchdown on Asteroid



Japan's Hayabusa 2 on 11 July 2019 performed a successful touchdown on Ryugu asteroid which is nearly 300 million km away from the Earth to collect samples from beneath the surface which can give insights into the solar system as it was at the time of its birth some 4.6 billion years ago. The brief landing on 11 July was the second time the spacecraft touched down on the asteroid. The first touchdown was in February, during which Hayabusa 2 briefly landed on the asteroid and fired a bullet into the surface to puff up dust for sample collection. The touchdown is the last major part of the mission and astronomers hope to understand more about the history of the solar system and the origin of life on Earth as well.

Black Hole Devouring Neutron Star Detected for the First Time

Astronomers from the Australian National University (ANU) detected a black hole devouring a neutron star for the first time. In August 2019, gravitational-wave discovery machines in the US and Italy spotted ripples in space and time from a cataclysmic event. "About 900 million

years ago, this black hole ate a very dense star, known as a neutron star, like Pacman - possibly snuffing out the star instantly," said Professor Scott, Leader of the General Relativity Theory and Data Analysis Group at ANU and Chief Investigator with the ARC Centre of Excellence for Gravitational Wave Discovery (OzGrav), in a ANU statement.

Giant Planet Orbiting Dead Dwarf Star

Astronomers from the University of Warwick's Department of Physics and the Millennium Nucleus for Planet Formation (NPF) at the University of Valparaiso have discovered a giant planet orbiting around a dead white dwarf star. The planet has been found in the form of a disc of gas formed from its evaporating atmosphere. The planet is Neptune-like and orbits a star four times its size once in ten days and leaves a comet-like tail of gas comprising hydrogen, oxygen and sulphur after its action. The discovery is the first ever of its kind and suggests that there could be more planets orbiting around dwarf stars yet to be discovered. The star WDJ0914+1914 was recognised in a study of ten thousand white dwarfs observed by the Sloan Digital Sky Survey. Till now there is no such evidence that any planet has withstood a star's transition to a white dwarf. The discovery was published in the journal *Nature*.

New Species

World Most Powerful Electric Eel

Scientists at Smithsonian's Museum

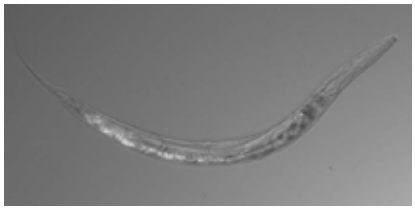
Adapted from the research paper (*Image Credit: Nature Communication*)

of Natural History discovered an approximately eight-feet-long eel (*Electrophorus voltai*) in the Amazon basin with a record-breaking voltage of 840 volts of electricity which is more than 650 volts discharged by earlier electric eel found. According to the study, the conductivity of water in which the eel lived may have influenced the voltage; the high voltage may be an adaptation to the poor conductivity of water. These eels use their shock method for self-defence, hunting prey and navigation. The study was published in *Nature Communications*.

New Rain Loving Species of Snake

A team of Indian scientists has discovered a "rain-loving" new snake species *Smithophis atemporalis* in Mizoram. The species is non-venomous, aquatic and its maximum size is 2.5 ft. They have a unique character as scales are absent in the "temporal" region of their head. The species has been named "Smithophis" after well-known British herpetologist, Malcolm Arthur Smith. The discovery is an outcome of more than six years of collaboration between scientists from leading Indian and international institutes. The finding was published in the New Zealand-based journal *Zootaxa*.

Worm with Three Sexes Discovered



Researchers at the California Institute of Technology have discovered a new species of nematode with three sexes in Mono Lake in California. It can survive a dosage of arsenic 500 times when compared to the dosage deadly to humans and has higher arsenic resistance when compared to other species of worm. Nematodes are either hermaphrodites or males. But, *Auanema sp.* also includes worms of the female sex. The worm also gives birth to live offspring, an exceptional case in the typically egg-laying nematode world. It carries its young ones in a pouch just like a kangaroo. It can survive easily in highly salty, alkaline waters of Mono Lake. The findings were published in *Current Biology*.

New Species of Stiletto Snake

Scientists have found a new species of snake that can deliver a venomous wound even without opening its mouth. This skill exclusively belongs to stiletto snakes, as they have long fangs which they can stick in and out of the corners of their mouths,

allowing these snakes to attack sideways. The newfound species, named as Branch's stiletto snake (*Atractaspis branchi*), resides in primary rainforest and rainforest edges of western Liberia and southeastern Guinea. The discovery was published in the journal *Zoosystematics and Evolution*.

Geology & Palaeontology

Lost Continent Discovered under Europe

Image Credit: Douwe van Hinsbergen, Utrecht University

Geologists have discovered a continent beneath southern Europe long-hidden for nearly 140 millions of years. The continent is called Greater Adria. It's the size of Greenland and it broke off from North Africa. The study was published in the journal *Gondwana Research*.

Fossils of the World's Largest Parrot ever Recorded

Palaeontologists have found the world's largest parrot named as *Heracles inexpectatus* in New Zealand. Its name *Heracles inexpectatus* reflects its Herculean myth-like size & strength and the unexpected nature of the discovery. The giant bird has been estimated to have weighed about seven kilograms, which would have been more than twice as heavy as the kākāpo, the previously known

largest parrot. The discovery has been recorded in the journal *Biology Letters*.

World's Smallest Fossil Monkey Uncovered in Amazon Forests

A group of scientists led by Duke University has discovered the 18-million-year-old remains of the smallest fossil monkey in the Amazon forests based on a single tooth which is twice the size of a pinhead recently unveiled in a riverbank in southeastern Peru. The discovery will bridge the gap to understand monkey evolution. The study has been reported in the *Journal of Human Evolution*. The animal has been dubbed as "*Parvimico materdei*" or "tiny monkey from the Mother of God River."

Fossilised tooth
(Image Credit: Duke University)

Nature & Environment

World's First Land-Based Commercial Coral Farm

Co-founder of Coral Vita, Gator Halpern, developed the world's first land-based commercial coral farm for resilient reef restoration in the Grand Bahamas. By using micro-fragmenting technology, the founder accelerates coral growth by more than 50 times and increases the speed of coral restoration over months instead of decades. Besides, species diversity can also be increased by this process.

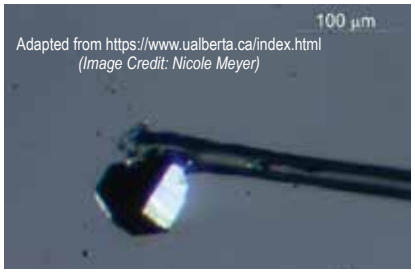
Gel-like Fluid to Prevent Wildfires

Stanford University researchers have developed a cellulose-based gel-like fluid which can be coated over vegetation by spraying through standard agricultural equipment or an aircraft to prevent wildfires. The technology could combat fire-outbreaks in the future. It contains non-toxic substances widely used in food, drugs and agricultural products. The study has been reported in *PNAS*.

New Plastic-eating Bacteria

Researchers from Shiv Nadar University, Greater Noida have discovered two strains of plastic-eating bacteria namely *Exiguobacterium sibiricum strain DR11* and *Exiguobacterium undae strain DR14* from the wetlands of Greater Noida capable of decomposing polystyrene, the key ingredient of single-use plastic items like disposable plates, cups, cutlery, packaging materials, toys, etc. Due to high molecular weight and long-chain polymer structure polystyrene is quite resistant to degradation and persists in the environment for a longer time. The discovery may be an eco-friendly alternative for plastic waste worldwide. The study has been published in the journal *Royal Society of Chemistry (RSC) Advances*.

Goldschmidtite — New Mineral in Diamond



A new and unusual mineral has been discovered by an Alberta student as inclusion in diamond from a volcanic site in South Africa. It was named as Goldschmidtite in honour of mineralogist Victor Moritz Goldschmidt. According to the study, the mineral is dark green and opaque found about 170 kilometres beneath the Earth's surface. Goldschmidtite contains a high concentration of niobium, potassium and rare elements. Potassium and niobium are the main components in the mineral which is very rare in the mantle. The research has been published in the *American Mineralogist*.

Unique Oil-Eating Bacteria at the Bottom of the Ocean

Scientists from the University of East Anglia in Norwich, along with researchers from China and Russia have discovered unique bacteria in the deepest part of the Earth's oceans — the Mariana Trench -- eats oil. During the study of the collected microbial population samples, researchers found a hydrocarbon-degrading bacteria which was abundant at the bottom of the Mariana Trench. Such microbes could eat compounds similar to those in oil and then could be used for fuel. The study was published in *Microbiome*.

Artificial Intelligence and Computers

Fedor — Humanoid Robot in Space

Russia's first humanoid life-sized robot "Fedor (Final Experimental Demonstration Object Research) or Skybot F850" was launched for a two-week mission to the International Space Station (ISS) on 22 August 2019. Fedor was sent in an uncrewed spacecraft (Soyuz MS-14) for use in operations that are risky for onboard humans. The size of the robot is 1.80 metres tall and 160 kg in weight and it mimics human body movements. The robot has its own Twitter and Instagram account on which it can upload every activity.

First-ever Successful Mind-controlled Robotic Arm

A group of researchers from Carnegie Mellon University in collaboration with the University of Minnesota has made a major breakthrough in the area of non-invasive robotic device control with the first-ever successful mind-controlled robotic arm non-invasive Brain-computer Interface (BCI) capable of tracking and following a computer cursor. The established framework addresses and improves upon the "brain" and "computer" components of BCI by enhancing the user engagement and training, and also by the spatial resolution of non-invasive neural data through EEG source imaging. The paper was published in *Science Robotics*.

International Environment Conferences 2019

1. Climate Action Summit: At the 74th session of the United Nations General Assembly, Indian Prime Minister Shri Narendra Modi addressed the United Nations Climate Action Summit and the Universal Health Coverage Meeting, held in New York on 23 September 2019.

- *Leadership Group:* India and Sweden together with other countries, announced a new 'Leadership Group for Industry Transition' to help guide the world's heaviest greenhouse gas emitting industries towards a low-carbon economy.
- *Coalition for Disaster Resilient Infrastructure (CDRI):* PM announced global Coalition for CDRI, an international partnership that will support both developed and developing countries to build climate and disaster-resilient infrastructure. The coalition's secretariat is based in Delhi.
- PM called for a "Global People's Movement" to bring about behavioural change to deal with climate change and made a pledge to more than double India's non-fossil fuel target to 400 gigawatts.

2. United Nations Convention to Combat Desertification (UNCCD): COP 14

- For the first time ever, India hosted the 14th session of the conference of Parties (COP 14) of the UNCCD, held at India Expo Mart Limited, Greater Noida from 2 to 13 September 2019.
- The theme of the Conference was "Restore land, Sustain future".
- The Conference adopted the Delhi Declaration in which parties expressed commitment for a range of issues, including gender and health, ecosystem restoration, taking action on climate change, private sector engagement, Peace Forest Initiative and recovery of five million hectares of degraded land in India.
- India, the global host for COP 14, has taken over the COP Presidency from China for the next two years until the next COP is hosted in 2021.

3. International Conference on Augmenting Nature

- An International Conference on Augmenting Nature by Green Affordable New-Habitat (ANGAN) was held from 9 to 11 September 2019 in New Delhi.
- The conference focused primarily on achieving Energy Efficiency in the building sector. It was organised by the Bureau of Energy Efficiency (BEE), Ministry of Power in collaboration with GIZ under the INDO German Technical Cooperation Initiative.

4. BRS Conventions COP in Geneva

- The 14th meeting of the Conference of the Parties to the Basel Convention (BC COP 14), the 9th meeting of the Conference of the Parties to the Rotterdam Convention (RC COP 9), and the 9th meeting of the Conference of the Parties to the Stockholm Convention (SC COP 9) held from 29 April to 10 May 2019, in Geneva.
- The theme of the meeting was "Clean Planet, Healthy People: Sound Management of Chemicals and waste".

5. Basel Convention in Geneva

- The 14th meeting of the Basel Convention, which laid down guidelines on the movement of hazardous waste, concluded in Geneva on 10 May 2019.
- A key outcome of the meeting was an amendment to the Convention that includes plastic waste in a legally-binding framework, which would make global trade in plastic waste more transparent and better regulated, whilst also ensuring that its management is safer for human health and the environment. However, it does not bar countries from exporting various categories of plastic waste.

6. International Stocktaking Conference on Tiger Conservation

- The 3rd International Stocktaking Conference on Tiger Conservation, relating to the Global Tiger Recovery Program (GTRP) implementation was held in New Delhi on 28 January 2019.
- The conference was hosted by the National Tiger Conservation Authority, Ministry of Environment, forest and Climate Change in close collaboration with the Global Tiger Forum.

7. COP 24

- The 24th meeting of the Conference of the Parties (COP 24) to the United Nations Framework Convention on Climate Change (UNFCCC) was concluded in Katowice, Poland.
- The conference finalised a rulebook for implementation of the Paris Agreement termed as "Katowice rule". The Paris climate pact will come into effect in 2020 and will replace the existing Kyoto Protocol.
- The 25th meeting of the Conference of the Parties (COP 25) will be held in Chile.

8. BASIC Meeting on Climate Change

- The BASIC countries held their 28th ministerial meeting on Climate Change from 14 to 16 August 2019 in Sao Paulo, Brazil.
- The BASIC Ministers urged developed countries to fulfil their climate finance commitments of mobilizing USD 100 billion annually by 2020 for developing countries in a transparent manner and on a grant basis.
- The BASIC group was formed as the result of an agreement signed by the four countries (Brazil, South Africa, India and China) on 28 November 2009.

9. World Sustainable Development Summit (WSDS), 2019

- The three-day World Sustainable Development Summit 2019 was inaugurated by the Vice President of India in New Delhi from 11-13 February 2019. The theme of the summit was "Attaining the 2030 Agenda: Delivering on our Promise".
- The WSDS is the annual flagship event of the Energy and Resources Institute (TERI).

10. UN Environment Assembly

- The 4th session of the UN Environment Assembly (UNEA-4) took place in Nairobi, Kenya. The theme of UNEA-4 was "Innovative Solutions for Environmental Challenges and Sustainable Consumption and Production".
- Nations unanimously agreed to significantly cut down on single-use plastic products like cups, cutlery and bags by 2030.
- Along with the summit, the United Nation Environment Program has also launched the Global Environment Outlook Report.

Wafer Scale Engine — World's Largest Processor

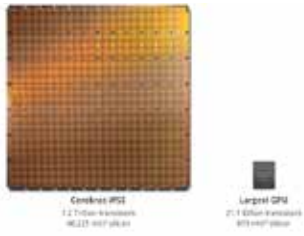


Image Credit: www.cerebras.net/

Startup Cerebras Systems, a California-based AI startup, has given the world the single-silicon-based largest processor with 1.2 trillion transistors called Wafer Scale Engine – a single chip optimised for AI tasks. The chip has fifty-six times more silicon area than the largest GPU (Graphics Processing Unit) and specially designed to enhance the work of AI.

Xin Xiaomeng — World's first Female AI News Anchor

China's Xinhua news agency in collaboration with Sogou Inc. (search engine company) came up with the world's first female AI (Artificial Intelligence) news anchor Xin Xiaomeng. The AI news anchor was modelled after the real-life news anchor Qu Meng on Xinhua.

First Contactless Cardiac Arrest AI System for Smart Speakers

Researchers at the University of Washington have developed the first contactless cardiac arrest AI system which monitors for cardiac arrest while a person is sleeping. It detects the gasping sound which is mainly heard during cardiac arrests. The system does not require any kind of touch and functions as an app or skill for smart speakers and smartphones. The team created a tool that accurately detects agonal breathing 97% of the time when a smart device is placed up to 6 meters or about 20 feet away from the user. The findings were published in the Nature journal *npj Digital Medicine*.

Biological Sciences

World's First-ever 3-D Heart

A team of scientists from the Tel Aviv University, Israel, has printed the world's first 3-D heart made from a human patient's tissue. Its size is similar to a rabbit's heart. This is the first successfully engineered and printed human heart filled with cells, blood vessels, ventricles and chambers. The technology has the potential to reduce dependency on organ donation. The study was published in the journal *Advanced Science*.

Image Credit: https://nypost.com

World's First Living Creature with Fully Synthetic DNA

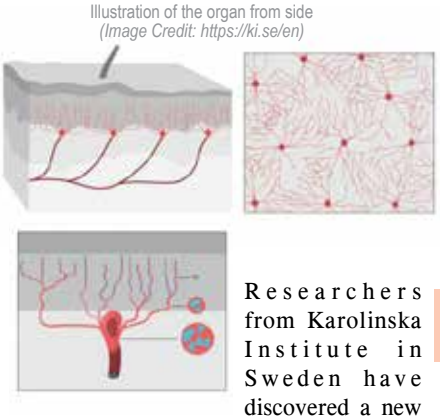
For the first time, scientists at Cambridge University artificially recreated *Escherichia coli* which has entirely synthetic and radically altered DNA code. The purpose of using the method is to better define the minimum set of genes required for a free-living cell. Before creating a synthetic version of *E.coli* DNA, scientists read & redesigned the DNA of *E.coli* and then created a microbe named *Syn61* made of synthetic and highly modified DNA. The bacterium is slightly longer as compared to its natural counterpart and takes longer to grow and survive. The study was published in *Nature*.

First Smartphone App to Detect Ear Infection

Image Credit: University of Washington

Scientists at Washington University have developed the first Smartphone App that can detect ear infection in children by detecting the fluid behind the eardrum. With the help of a piece of paper, the Smartphone's microphone and speaker, the fluid can easily be detected with the probability of 85%. The ear infections can then be treated with proper medication and monitoring once the problem is diagnosed. The study was published in the journal *Science Translational Medicine*.

New Sensory Organ Discovered



Researchers from Karolinska Institute in Sweden have discovered a new sensation organ in skin which is sensitive to the risky environmental irritation and capable of detecting painful mechanical damage. The newly found organ comprises glia cells which have multiple long protrusions and collectively make a mesh-like organ within the skin. The study was published in *Science*.

Great White Shark's Genome Decoded

Researchers from Nova Southeastern University's (NSU) Save our Seas Foundation, Shark Research Centre and Guy Harvey Research Institute (GHRI), Cornell University College of Veterinary Medicine, and Monterey Bay Aquarium, decoded the white shark genome and compared it with genomes of other vertebrates, including the giant whale shark and humans. Decoding the white shark's genome showed not only its huge size i.e., 1.5 times the size of the human genome, but also a plethora of genetic changes which led to the evolutionary success of these sharks. This research has potential applications in the field of health and disease prevention. The findings are reported in the journal *Proceedings of the National Academy of Sciences (PNAS)*.

New Type of Skin-cell Coordinates Tail Regeneration

Image Credit: phys.org

A team of scientists from Cambridge University found a specialised population of new type of skin-cells responsible for tail regeneration in tadpoles. These Regeneration Organizing Cells (ROC) provide an opportunity to understand how this ability can be achieved in mammalian tissues also. Using single-cell genomics, the scientists of Cambridge University tried to unveil how this regeneration of tail happens in different tadpole cells. The study was published in *Science*.

Physical Sciences

Kilogram Redefined

Based on a historic decision at the General Conference on Weights and Measures in Versailles, France, organised by the International Bureau of Weights and Measures (BIPM), all the SI units would now be defined in terms of constants that describe the natural world. Four

fundamental units — Kilogram, Kelvin, Mole & Ampere — have undergone a change which came into force worldwide on the World Metrology Day celebrated on 20 May 2019.

Discovery of New Property of Light

Researchers from several institutes of Spain and the US have discovered a new property of light. Interestingly, the scientists found that light can also be twisted, a property called angular momentum which has highly structured angular momentum known as Orbital Angular Momentum (OAM). In these types of beams, mini waves rotate around the centre of the beam in the form of the helix giving it the shape of a doughnut. The researchers combined pairs of waves with the same orbital angular momentum and fired them into a cloud of argon gas from where a single twisted croissant-shaped light emerged. The researchers finally concluded that there is a force named self-torque responsible for twisting the light as well as altering the speed at which light waves twist. The study was published in *Science*.

Researchers Discover First Supersymmetric Laser Array

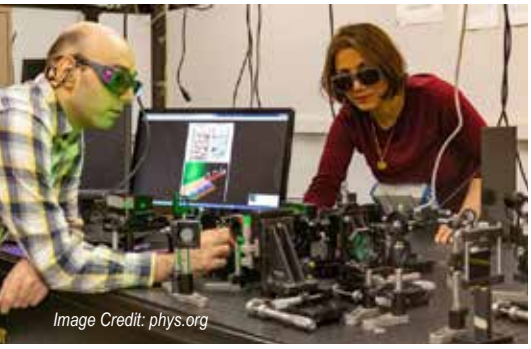
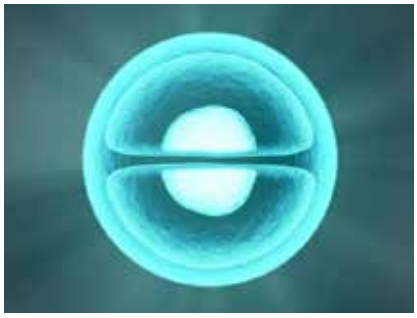


Image Credit: phys.org

A team of researchers at the Central Florida University has developed the first supersymmetric laser array overcoming the long-standing problem in laser science. The new finding will have applications in many surgeries, drilling, military, industry, communications and 3D laser mapping. The technique is based on the principle of 'supersymmetry'. It has a high power integrated laser array with a high-quality beam emission comprising rows of laser and also able to produce large outputs. The supersymmetric laser array not only provides integrated high power solutions but can also help to show high beam quality. The study was published in *Science*.

Chain-melted State of Matter



A team of physicists led by the University of Edinburgh discovered a new state of physical matter — "chain-melted state" — which can exist as both solid and liquid at the same time when subjected to extreme conditions. The study has been published in *Proceedings of the National Academy of Sciences*.

Quantum Entanglement Captured on Camera for the First Time


Image Credit: https://www.gla.ac.uk

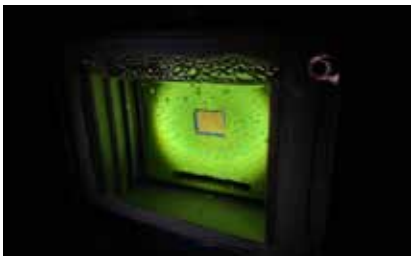
In a breathtaking view, for the first time physicists from the University of Glasgow in Scotland captured on camera a strong form of quantum entanglement known as Bell entanglement giving visual proof of an elusive phenomenon which was once called 'spooky action at a distance' and puzzled Albert Einstein. The results were published in the journal *Science Advances*.

Technology

Artificial Leaf — Producing Synthetic Gas

Researchers from Cambridge University created an artificial leaf powered by sunlight, water and carbon dioxide that produces synthetic gas. The artificial leaf comprises two light absorbers similar to the

Image Credit: https://www.gla.ac.uk



molecules of plant that collect sunlight and combine with the cobalt catalyst. When in water using the catalyst, one light absorber produces oxygen and the other carries the chemical reaction that reduces carbon dioxide and water into carbon monoxide and hydrogen making it a syngas mixture. The key feature of the artificial leaf is that it can operate even in cloudy and rainy days. The study has been published in *Nature Materials*. The technology can eventually be helpful to have a sustainable liquid-fuel alternative to gasoline.

Nanoseaweed — Thinnest Gold in the World


Image Credit: http://www.leeds.ac.uk/

Scientists at the University of Leeds, UK, have developed a new form of gold "Nanoseaweed", just two atoms (0.47 nanometres) thick. It is a million times thinner than the human fingernail, and the thinnest unsupported gold ever developed. The colour of the thinnest gold in water appears green therefore researchers named it nanoseaweed. The newly formed gold has been reported in the journal *Advanced Science*.

Installation of the World's Highest Weather Stations


Adapted from https://blog.nationalgeographic.org/
(Image Credit: Mark Fisher, National Geographic)

Climate researchers and the multi-disciplinary group led by scientists from National Geographic Society (NGS) and Tribhuvan University, Nepal and in partnership with Rolex, in a single scientific expedition to the Mount Everest have made history by installing the world's highest operating weather station at Mount Everest's Death Zone along with other automated stations on other parts of the mountain. The stations were installed to monitor and understand the climate change at higher altitudes and also for predicting weather patterns around the globe.

World's First Armed Amphibious Drone Boat

"Marine Lizard", the world's first armed amphibious drone developed by Wuchang Shipbuilding Industry Group under China Shipbuilding Industry Corporation (CSIC) was successfully tested. The drone which is remotely controlled by satellites can reach a maximum speed of 50 knots. The 12-metre long drone is capable of forming a combat triad with aerial drones and other drone ships and could be used in land assault operations.

Indian S&T 2019

Mission Shakti — India's ASAT Missile Programme

Image Credit: livemint.com

With the test launch of the first Anti-satellite (ASAT) missile programme, India became the fourth nation in the world to successfully test an anti-satellite missile by destroying a Low Earth Orbit (LEO) satellite Microsat-R built by DRDO (Defence Research and Development Organisation). Mission Shakti holds the potential to safeguard the nation's space assets.

Chandrayaan-2 — A Shot at the Lunar South Pole

Image Credit: www.gadgets.ndtv.com

Chandrayaan-2 was ISRO's most challenging first inter-planetary mission designed to soft-land *Vikram* lander on the South Pole of the Moon, which would have been the first for any nation as the area has not been explored by other missions. The Moon's South Pole is a tricky place with old rocks formed millions of years ago and their study could possibly help to understand the origin of the universe. Although the landing was not as desired, the *Chandrayaan*-2 orbiter will continue to orbit the Moon at a height of 100 kilometres almost for seven years instead of the planned one year.

India Unveils 28 New Milky Way Stars

Scientists at ARIES (Aryabhatta Research Institute of Observational Sciences), Nainital, discovered twenty-eight new variable stars in the outer part of the Milky Way Galaxy by using a powerful 3.6-metre optical telescope, the Devasthal Optical Telescope. The stars were found in the Globular cluster NGC 4147 in the constellation of Coma Berenices.

TIFR Scientists Develop New Wonder Material — Black Gold

Researchers at the Tata Institute of Fundamental Research (TIFR), Mumbai, have created a new material called "Black Gold" with unique qualities like the capacity to absorb light and carbon dioxide. It has been developed by rearranging the gaps and the size of gold nanoparticles. As the name implies, it is black in colour and has various applications ranging from harvesting solar energy to desalinating seawater. The research has been detailed in the journal *Chemical Science*.

GraspMan — A Multimodal Robotic System

Researchers at IIT (Indian Institute of Technology) Madras have developed and fabricated a multimodal robotic system called "GraspMan" for field and industrial application as it possesses very good grasping, locomotion and manipulating capabilities. The system consists of a pair of graspers which can hold things securely and is also capable of manipulating it much like the hand of a

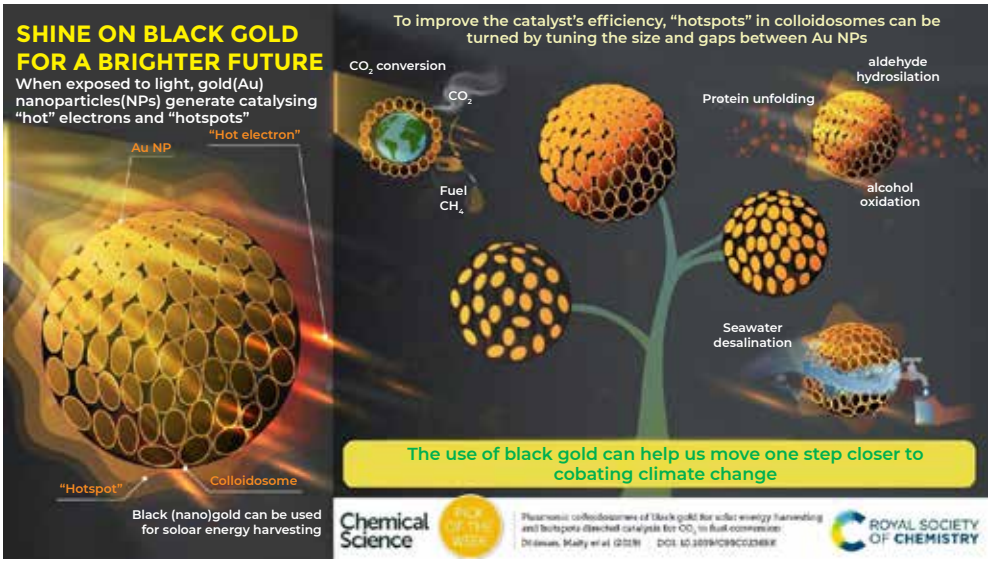


Image Credit: http://www.tifr.res.in/

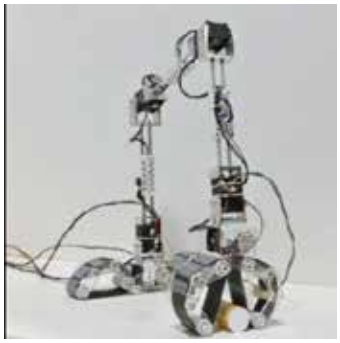


Image Credit: https://yourstory.com/

human being. The recent development has been published in ASME's (The American Society of Mechanical Engineers) peer-reviewed *Journal of Mechanisms and Robotics*.

Smallest Orchids Discovered

Lecanorchis taiwaniana, a Japanese orchid variant, has been accidentally discovered in Assam by a Forest Officer. It is one of the smallest orchids in terms of size and bloom duration. The orchid is a parasitic plant. The discovery has been reported in the *Journal of Botany* as a "new record for the flora in India".

AJIT — India's First Indigenously Developed Microprocessor

Engineers at IIT Bombay have indigenously developed and fabricated a microprocessor called AJIT, the first homegrown microprocessor. The technology not only

Image Credit: http://www.iitb.ac.in/

can reduce the nation's imports but also make India self-reliant in electronics. The project was funded by the Ministry of Electronics and Information Technology (MeitY) and IIT Bombay.

India's First Humanoid RoboCop

India's first humanoid police robot KP-BOT was inaugurated in Kerala and has been given the rank of Sub-inspector (SI) at the Police Headquarter, Thiruvananthapuram, Kerala. Embracing a progressively automated future of the nation, Kerela has become the first-ever police department in the nation to deploy a robot for police task.

Council of Scientific & Industrial Research (CSIR)

Whole Genome Sequencing of 1000 Indians

The Council of Scientific and Industrial Research (CSIR) has sequenced the genome of 1000 Indians from different populations. This was achieved as part of the IndiGen initiative undertaken by CSIR in April 2019, and implemented by the CSIR-Institute of Genomics and Integrative Biology (CSIR-IGIB), New Delhi and CSIR-Centre for Cellular and Molecular Biology (CSIR-CCMB), Hyderabad.

The genome sequencing and computational analysis of 1008 Indians was accomplished in six months demonstrating scalability at an industrial scale in a defined timeline. The development could signal a major step towards enabling predictive and preventive medicine.

First Indigenous High-Temperature Fuel Cell System by CSIR

The first-ever high-temperature indigenous fuel cell was unveiled by the President of India, Shri Ram Nath Kovind on the occasion of the CSIR Foundation Day on 26 September 2019. The fuel cell system has been developed by the Council of Scientific and Industrial Research (CSIR) in collaboration with Indian industries under the programme New Millennium Indian Technology Leadership Initiative (NMITLI). The cell will replace diesel generating sets thereby helping reduce India's reliance on crude oil. It will be useful for stationary power applications in small offices, commercial units, data

centres, etc., where reliable power is necessary along with a concurrent necessity for air-conditioning. It will fulfil the requirements of efficient, clean and reliable backup power generation for telecom towers, remote locations, and will be useful for strategic applications too.

Biodiesel Plant by CSIR-CMERI

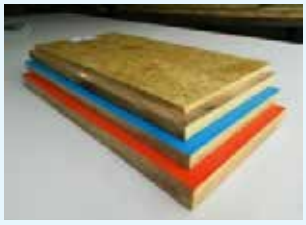
CSIR-CMERI (Central Mechanical Engineering Research Institute), Ludhiana, has designed and developed a biodiesel plant that can carry out the conversion of Tung oil from Tung Tree (*Aleurites fordii*) into biodiesel. The oil has various industrial applications such as in ceramic, paint, paper and cloth production. Tung oil *(Aleurites fordii)* has been regarded as a promising non-edible source of biodiesel production. The plant has been tested at CSIR-CMERI. The capacity of the plant is 600 litres/day and it is able to produce biodiesel from any edible and non-edible vegetable oil irrespective of its FFA (Free Fatty Acids) content.

CSIR Develops Solutions for Parali Burning

To provide a solution to the burning of agro-waste *parali* in Delhi and neighbouring States (Haryana, Punjab and Uttar Pradesh), scientists from CSIR-AMPRI, Bhopal, have developed techniques to convert agro-waste residues, especially paddy, wheat and

maize straw into commercially viable materials equivalent or better than that of commercially available synthetic wood such as particleboard, plywood, etc.

Meanwhile, scientists from the CSIR-National Physical Laboratory (NPL), New Delhi, have suggested the conversion of paddy biomass into green 'bio coal' which be used in thermal power plants. According to a study published in *Current Science*, the conversion of paddy stubble into green product bio coal can be done through torrefaction. This process will also help farmers to earn money using the agriculture residue.



Composite materials developed from wheat straw by CSIR-AMPRI Bhopal

The residue of other crops like wheat, sugarcane, oilseed, maize and cotton can also be used as bio coal in thermal plants after the torrefaction has been carried out.

CSIR-NPL Creates Device for Single-layer Graphene

Researchers at Delhi's National Physical Laboratory (CSIR-NPL) have designed and developed a low-pressure chemical vapour deposition (LPCVD) device that allows high quality, single-layer graphene measuring 4 inches in length and 2 inches in breadth to be grown. The graphene produced is metrology-grade, and can be used in next-generation quantum devices.

The LPCVD device costs about Rs 5,00,000, which is one-tenth of the imported ones. The quality of the single-layer graphene grown using this device is also superior as compared to the imported ones. The research has been published in *ACS Omega*.

CSIR-CCMB Develops Antimicrobial Protein «Echamp»

Scientists at CSIR-CCMB (Centre for Cellular and Molecular Biology) Hyderabad, have found a new mechanism in order to inhibit bacterial growth. The research will pave the way for novel antibiotics to fight against infections resistant to drugs.

The scientists isolated an Antimicrobial Protein (AMP) from the milk of a unique egg-laying mammal, Echidna. The extracted protein may serve as a promising alternative to antibiotics used in livestock. The Antimicrobial Protein (AMP) in the milk of the mammal is capable of puncturing the cell membranes of multiple bacterial species thereby destroying the infection. The study has been published in the journal *Biochimica et Biophysica Acta–Biomembranes*.

"JALDOST" for Flood Rescue & De-Weeding

On 1 June 2019, CSIR-National Aerospace Laboratories (CSIR-NAL) launched JALDOST, an airboat at the Ulsoor Lake in central Bengaluru, which can be used for flood relief as well as for weeding in waterbodies. The boat uses stainless steel cutters that facilitate cutting of rooted weeds in water bodies. The system uses hydraulic power from the engine to cut weeds and is also fitted with equipment to scoop them up.

The boat launched in the Ulsoor lake is a prototype and can accommodate one crew member and three passengers.

The airboat was constructed using technology used in low-cost aircraft. Since there are no moving parts below the water surface, there is no risk of entanglement with objects underwater not easily identifiable. Jalboat' can travel in locations where conventional boats are not practicable.

Green Technologies for Quality Drinking Water

CSIR-CMERI (Central Mechanical Engineering Research Institute), Durgapur has developed three technologies for supply of quality drinking water from groundwater sources. The recently developed technologies are based on the principles of oxidation, precipitation and filtration and do not require electric power and so are completely green.

CSIR-NIIST Launches Coir-based Mulching Mats

CSIR-National Institute for Interdisciplinary Science and Technology (CSIR-NIIST) has developed coir-based mulching mats which are biodegradable and a greener alternative to plastic. These mulching films were developed under a collaborative research project with the National Coir Research and Management Institute (NCRMI), Government of Kerala, Kerala.

Process Developed to Extract Potash from Spent Wash

A spent wash management technology developed by CSIR-Central Salt and Marine Chemicals Research Institute, Bhavnagar will enable alcohol distilleries to recover valuable byproducts from their effluents. The sugarcane (molasses)-based alcohol distilleries generate eight to 15 litres of spent wash to produce a single litre of ethanol. The spent wash is a highly polluting liquid residual waste, which poses serious environmental hazards. The Institute has developed the process to extract potash from the liquid effluent (spent wash). The potash can be used as a fertilizer. This will result in foreign exchange savings to the tune of ₹500 to ₹700 crores a year through reduced dependence on fertilizer imports.