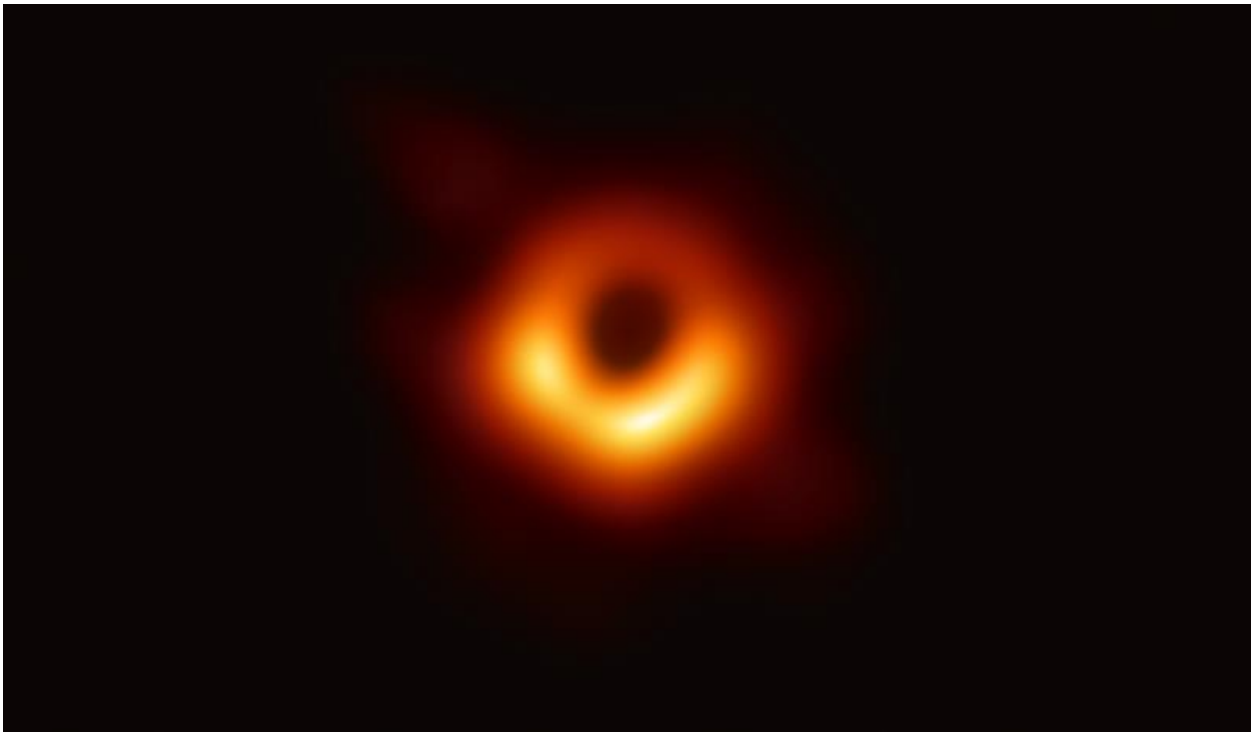
New frontiers in Science in 2019: From Black Hole Image to Artificial Embryo – Many Firsts

First Image of Black Hole

The year 2019 saw the contribution of cutting edge innovations in science and technology helping the mankind in better understanding of complexities and realities of the universe. The International Event Horizon Telescope collaboration which consists of a global network of radio telescopes is one such state-of-the-art innovations. The Event Horizon Telescope is a large telescope array consisting of a global network of radio telescopes. The EHT project combines data from several very-long-baseline interferometry stations around Earth with angular resolution sufficient to observe objects the size of a supermassive black hole's event horizon.



First Imaging of Black Hole by EHT Credit: https://eventhorizontelescope.org/

The imaging of the black hole is a spectacular revelation that is simultaneously a recognition and celebration of science, Aryan Banerjee, from the Indian Institute of Science Education and Research (IISER) in Kolkata said. The first image of a black hole, at the center of galaxy Messier 87, was published by the EHT Collaboration on

April 10, 2019, in a series of six scientific publications. The array made this observation at a wavelength of 1.3 mm and with a theoretical diffraction-limited resolution of 25 microarcseconds. Future plans involve improving the array's resolution by adding new telescopes and by taking shorter-wavelength observations.

EHT produced enormous amounts of data – roughly 30 terabytes per day – which was stored on high-performance helium-filled hard drives. The data collected was so massive that it couldn't be transmitted over the internet. Instead the hard drives had to be flown to four teams of scientists at the Max Planck Institute for Radio Astronomy and MIT Haystack Observatory. This raw data, which was in petabytes, was fed to highly specialised supercomputers, known as correlators. They were then painstakingly converted into an image using novel computational tools developed by the collaboration.

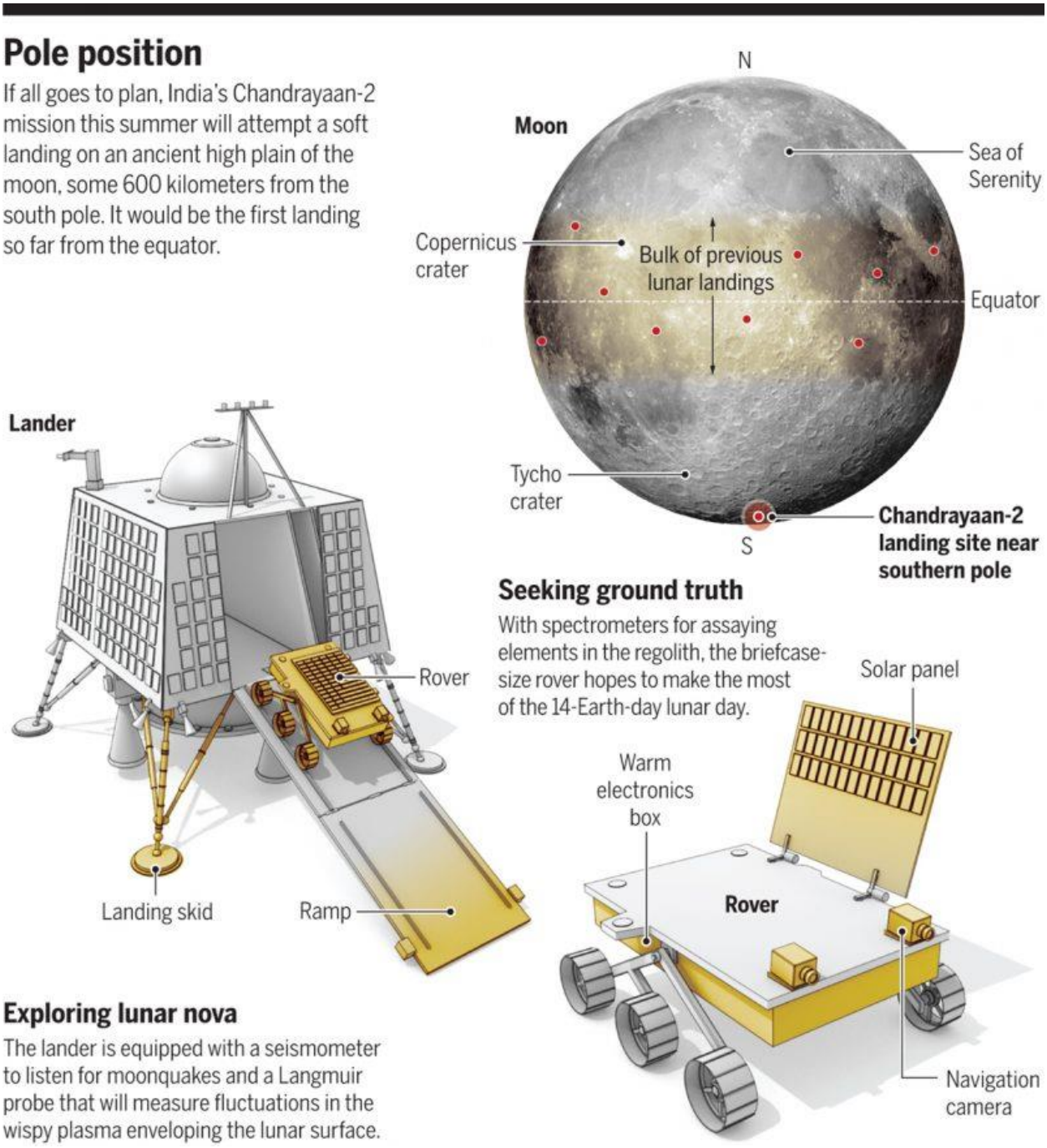
A black hole is generally defined as a region in space where gravitational pull is so powerful that even light cannot escape. The gravity of a black hole is so strong because matter has been squeezed into a tiny space. The idea of an object so massive that even light cannot escape the pull of its gravity was first mooted way back in 1783. By Cambridge Professor John Michell.

Chandrayan-2 *India's First Attempt to Land a Rover* at the South Pole of Moon

In 2019, India attempted to land its spacecraft Chandrayaan-2 Vikram Lander on the lunar surface. Chandrayaan-2 mission is a highly complex mission, which represents a significant technological leap compared to the previous missions of ISRO, which brought together an Orbiter, Lander and Rover with the goal of exploring south pole of the Moon. This is a unique mission which aims at studying not just one area of the Moon but all the areas combining the exosphere, the surface as well as the sub-surface of the moon in a single mission.

The mission's lander is called Vikram (Sanskrit: विक्रम, lit.'Valour') named after Vikram Sarabhai (1919–1971), who is widely regarded as the founder of the Indian space programme. The Vikram lander detached from the orbiter and descended to a low lunar orbit of 30 km × 100 km (19 mi × 62 mi) using its 800 N (180 lbf) liquid main engines. It then performed a comprehensive check of all its on-board systems before

attempting a soft landing that would have deployed the rover, and perform scientific activities for approximately 14 Earth days. **But unfortunately Vikram spacecraft crash-landed.** The approximate combined mass of the lander and rover was 1,471 kg.



Infographic Credit: https://earthsky.org/space/india-mission-chandrayaan-2-moon-south-pole

Though India's first moon mission with one of the major objectives to land a lander with a explorer rover named Pragyan, mankind saw another successful attempt of achieving a similar feat carried out by China. **In January 2019, China's Chang'e-4 probe became the first spacecraft to land safely on the far side of the Moon.** Its rover

Yutu-2 continues to roll across the dusty soils of Von Karman crater on the lunar body. It achieved the first soft landing on the far side of the Moon, on 3 January 2019

NASA's Mars InSight lander has measured and recorded for the *first time* ever a likely "marsquake."

NASA's Mars InSight lander has measured and recorded for the first time ever a likely 'marsquake'. This is the first recorded trembling that appears to have come from inside the planet, as opposed to being caused by forces above the surface, such as wind.

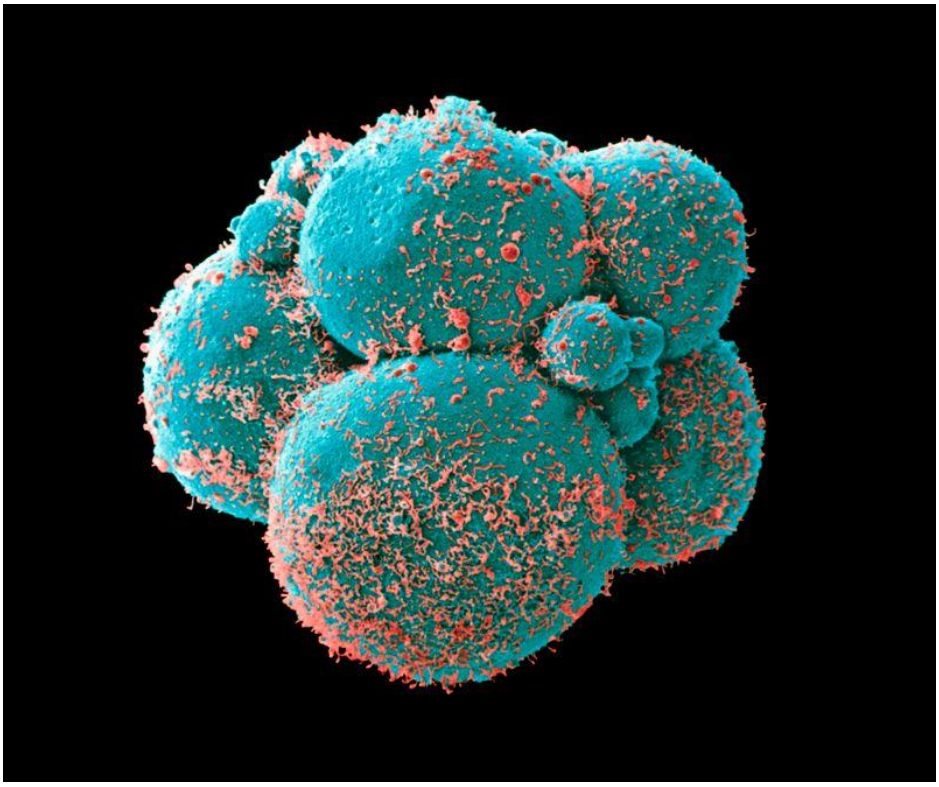
The faint seismic signal, detected by the lander's Seismic Experiment for Interior Structure (SEIS) instrument, was recorded on April 6, the lander's 128th Martian day, or sol. This is the first recorded trembling that appears to have come from inside the planet, as opposed to being caused by forces above the surface, such as wind. Scientists still are examining the data to determine the exact cause of the signal.

InSight's first readings carry on the science that began with NASA's Apollo missions," said InSight Principal Investigator Bruce Banerdt of NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California. "We've been collecting background noise up until now, but this first event officially kicks off a new field: Martian seismology!" The new seismic event was too small to provide solid data on the Martian interior, which is one of InSight's main objectives. The Martian surface is extremely quiet, allowing SEIS, InSight's specially designed seismometer, to pick up faint rumbles. In contrast, Earth's surface is quivering constantly from seismic noise created by oceans and weather. An event of this size in Southern California would be lost among dozens of tiny crackles that occur every day. The new seismic event was too small to provide solid data on the Martian interior, which is one of InSight's main objectives. The Martian surface is extremely quiet, allowing SEIS, InSight's specially designed seismometer, to pick up faint rumbles. In contrast, Earth's surface is quivering constantly from seismic noise created by oceans and weather. An event of this size in Southern California would be lost among dozens of tiny crackles that occur every day.

First Artificial Embryo from Human Stem Cell

In September 2019, researchers at the University of Michigan in the US developed a way to use human stem cells using human stem cells to make ‘artificial embryos' that mimic the early development of a real human embryo. The embryo-like structures are the first to produce rudimentary reproductive cells; and also go through stages that resemble several other landmarks in early human development.

“Our stem cell structures that mimic embryos can help fill critical gaps in knowledge about early human development, and that could lead to a lot of good,” Jianping Fu, an associate professor at Michigan, who led the study, said in a statement.



An early human embryo. Structures with similar features could be used to study human development.Credit: Dr Yorgos Nikas/SPL

(Source: https://www.nature.com/articles/d41586-019-02654-w)

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