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Mission Chandrayaan

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Abstract:

India made history after Chandrayaan-3's soft landing making India the first nation to land on the moon's south pole. In this essay I've discussed all the three Chandrayaan, their history, background and achievements.

1. Introduction:

Chandrayaan-3 is India's third lunar mission and its most ambitious till date. It is a follow-up to the Chandrayaan-2 mission, which was launched in 2019 but experienced a hard landing on the Moon. Chandrayaan-3 was launched by India on July 14, 2023 from the Satish Dhawan Space Center in Sriharikota, Andhra Pradesh. It entered an earth parking orbit with a perigee of 170 Km (106 mi) and an apogee of 36,500 Km 922, (680 mi).

2. Aims/ Objectives:

The primary objectives of Chandrayaan-3 were to -

- Demonstrate soft landing capability on the lunar surface,
- Deploy and operate a rover on the Moon,
- Study the lunar surface topography, mineralogy, and elemental composition,
- Study the lunar atmosphere and exosphere, lunar plasma environment and the lunar gravity field.
- Map the lunar water ice distribution.

3. Global Mission and Scientific Expedition:

Since early times many spacecrafts have been sent to space which has helped us to understand the universe and increase our knowledge, while also giving rise to new questions. Some of the most important missions of all times are-

(1) **Apollo-8:** The first crewed spacecraft to orbit another celestial body.
(2) **Apollo-11:** The first crewed spacecraft to land humans on another celestial body.
(3) **OSIRIS-Rex:** NASA's[1] first asteroid sample return mission.
(4) **Apollo-7**[2]**:** The first Apollo mission to get to space.

[1] The National Aeronautics and Space Administration (NASA), US. https://www.nasa.gov
[2] www.wikipedia.com, www.space.com

(5) Apollo 9: The first flight test of the lunar module.
(6) Mars Express: The European Space Agency's first planetary mission.
(7) Roscosmos: The only human space flight provider to the international community.

4. Indian Mission and Scientific Expedition from Ancient to Present:

The Indian Space Research Organization (ISRO)[3] was established on August 15,1969. It was previously known as the Indian National committee for Space Research (INCOSPAR)[4]. INCOSPAR was established in 1962 by Dr. Vikram Sarabhai. The Department of Space (DoS)[5] was created in 1972 and ISRO became a part of it. ISRO's main aim included to develop and harness space technology for national development and to pursue space science research and planetary exploration. ISRO made India proud a number of times since its inception in 1969. With 124 spacecraft missions and 94 launches, it is one of the elites among space organizations worldwide. Let's have a look at some successful missions of ISRO. India's first satellite, Aryabhata[6], which was named after legendary astronomer Aryabhata, was a huge success which instilled hopes in the minds of Indians for the upcoming missions. India's next successful and helpful mission brought a revolution in the telecommunication sector of India. It was called Indian National Satellite (INSAT)[7] system which has over 200 correspondents and provides television transmission, satellite negator, social applications, weather forecasting, catastrophe warning, and search and research activities. Geosynchronous Satellites (GSAT satellites) are other communication satellites constructed in India. Out of many GSAT satellites launched by India, 18 is still operational. With the Mars Operator Mission, popularly known as MOM, India became the first nation to reach the red planet in its first try. The mission was also the nation's first interplanetary mission. With this, ISRO became the fourth space agency to successfully launch a spacecraft into orbit around Mars[8]. Out of all its achievements recently, the most talked about achievement of ISRO is its mission to the Moon. It consisted of three spacecraft namely the Chandrayaan-1, Chandrayaan-2, and Chandrayaan-3.

4.1 Chandrayaan-1:

India's first lunar mission was a groundbreaking achievement that marked a new era in the country's space program. Launched on October 22, 2008, the spacecraft consisted of an orbiter, a lander, and a rover. The orbiter was successfully inserted into lunar orbit on November 8, 2008, and the mission continued to collect valuable data for nearly two years until August 29, 2009.

[3] The Indian Space Research Organization www.isro.gov.in
[4] The Indian National committee for Space Research was established in 1962
[5] Department of space has the primary objective of promoting development and application of space science and technology to assist in all-round development of the nation.
[6] Aryabhata was India's first satellite, named after the astronomer. It was launched on 19 April 1975
[7] Indian National Satellite (INSAT) www.mosdac.gov.in
[8] www.jagranjosh.com

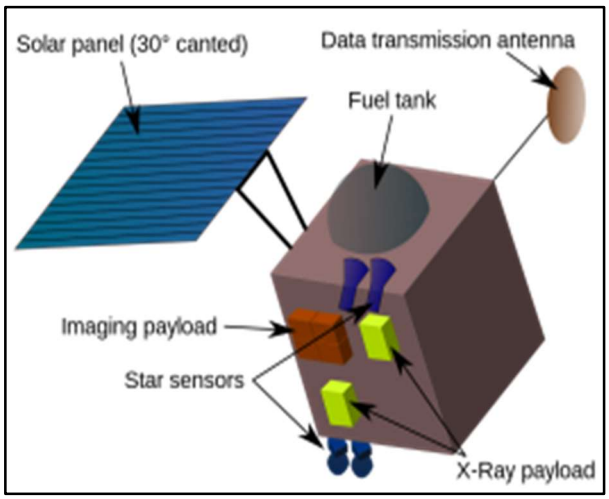

Figure-1: Chandrayaan-1[9]

Chandrayaan-1[10] carried a suite of 11 scientific instruments, including both Indian and international payloads. The orbiter's instruments were used to map the lunar surface in high resolution, study the lunar atmosphere and exosphere, and search for water in the form of ice. The lander's instruments were designed to measure the lunar surface composition and structure, and to study the lunar environment. A lot of information was gained through Chandrayaan-1. We came to know about a lot of things like the presence of ice in the polar region of the moon and a new type of lunar rock called "massif anthracite".

Additionally, lunar craters and other features of the moon were mapped in high resolution. The composition and structure of the lunar surface were also measured. The mission also provided valuable data on the moon's gravitational field and magnetic field along with the moon's atmosphere and exosphere.

Chandrayaan-1 was a resounding success for India, demonstrating the country's growing capabilities in space exploration. Discoveries of the Chandrayaan-1 have had a significant impact on our understanding of the Moon. The mission's data has been used to refine models of the Moon's formation and evolution, and to identify potential landing sites for future missions. The mission's instruments were some of the most sophisticated ever sent to the Moon, and they have helped to develop new technologies for future lunar missions. For example, the orbiter's Terrain Mapping Camera (TMC)[11] was the first Indian-built instrument to be used in lunar exploration. The mission's data has also been used to develop new software for processing and analyzing lunar data. This software will be used by scientists to study the data from future lunar missions.
Legacy of the Chandrayaan-1 is one of innovation, inspiration, and international collaboration. The mission demonstrated India's growing capabilities in space exploration and helped to boost the country's international reputation as a leader in the study of space and technology. It has also

[9] Figure-1 Wikipedia www.wikipedia.com
[10] Chandrayaan-1 was the first Indian lunar probe under the Chandrayaan programme. It was launched by the Indian Space Research Organization (ISRO) in October 2008
[11] The Terrain Mapping Camera (TMC) on India's first satellite for lunar exploration, Chandrayaan-1, is for generating high-resolution 3-dimensional maps of the Moon. www.springer.com

inspired a new generation of scientists and engineers in India. The mission showed that India could achieve great things in space, and it encouraged many young people to pursue careers in STEM. Chandrayaan-1 was a landmark mission in India's space program. It was the country's first lunar mission, and it achieved a number of significant scientific and technological breakthroughs. Chandrayaan-1's discoveries have helped us to better understand the Moon, and its legacy continues to inspire and inform future lunar exploration. After the huge success of Chandrayaan-1 ISRO made another spacecraft for lunar surface exploration in 2019 called "Chandrayaan-2". Chandrayaan-2 was India's second lunar mission and the most ambitious space mission undertaken by the Indian Space Research Organization (ISRO) to date. Launched on July 22, 2019, the mission consisted of an orbiter, a lander (Vikram), and a rover (Pragyan)[12]. The orbiter successfully inserted itself into lunar orbit on August 7, 2019, and continued to collect valuable data for over three years.

4.2 Chandrayaan-2:

The lander and rover were designed to explore the unexplored South Pole of the Moon, which is believed to be rich in resources such as ice. The lander was scheduled to soft-land on the lunar surface on September 7, 2019, but lost communication with the orbiter during the final descent phase. The rover was to be deployed from the lander after a successful soft landing. While the lander landing was not successful, Chandrayaan-2[14] was still a remarkable achievement for India. The orbiter continues to orbit the Moon and has provided valuable data on the lunar surface, atmosphere, and exosphere. The orbiter's findings have helped to confirm the presence of ice in the Moon's polar regions and have shed new light on the Moon's geological history. elemental composition, the lunar atmosphere and exosphere, the lunar plasma environment, the lunar gravity field and the lunar surface processes. Additionally, it's another objective was to map the lunar water ice distribution.

Figure-2: Chandrayaan-2[13]

Some of its scientific objectives were to study the lunar surface topography, mineralogy, and Chandrayaan-2 carried a suite of 13 scientific instruments, including both Indian and international payloads.

The orbiter's instruments included-

[12] Chandrayaan-1 had a lander vikram and a rover pragyan www.indiatimes.com
[13] Figure-2 this photo was uploaded by isro on its official website www.isro.gov.in
[14] Chandrayaan-2 mission was successfully launched on 22nd July 2019

(i) Terrain Mapping Camera (TMC);
(ii) HySI Imaging Spectrometer (HySI);
(iii) Large Area Soft X-ray Spectrometer (CLASS);
(iv) Chandrayaan-2 Atmospheric Composition Explorer (CHACE-2);
(v) Solar X-ray Monitor (XSM);
(vi) Dual Frequency Synthetic Aperture Radar (DFSAR);
(vii) Radio Beacon Experiment (RBX);
(viii) The lander's instruments included- Seismic Experiment for Interior Structure (SEIS);
(ix) Thermal Infrared Imaging Spectrometer (TIS);
(x) Radio Frequency Sensor for Probing Lunar Plasma (RF Plasma Analyzer) Chandra's Surface Thermo-Physical Experiment (ChSTE);
(xi) Langmuir Probe (LP);
(xii)The rover's instruments included: Alpha Particle X-ray Spectrometer (APXS);
(xiii) Laser-Induced Breakdown Spectroscope (LIBS);
(xiv) Panoramic Camera (Pancam) Subsurface Thermophysical Properties Experiment (Sub-TEPE)[15]

Chandrayaan-2 has made a significant impact on our understanding of the Moon. The orbiter's data has been used to refine models of the Moon's formation and evolution, and to identify potential landing sites for future missions. The orbiter's findings have also helped to confirm the presence of ice in the Moon's polar regions, which is a major discovery for lunar science.

Chandrayaan-2 has also advanced space science and technology in a number of ways. The mission's instruments were some of the most sophisticated ever sent to the Moon, and they had helped to develop new technologies for future lunar missions. For example, the orbiter's Terrain Mapping Camera (TMC) and Hyper Spectral Imager (HySI) have produced the highest resolution images of the lunar surface ever taken. These images were being used to create detailed maps of the Moon, which is being used by scientists and engineers to plan future missions. The mission's data is also being used to develop new software for processing and analyzing lunar data. This software was used by scientists to study the data for future lunar missions.

Chandrayaan-2 was an ambitious mission that pushed the boundaries of India's space program. While the lander landing was not successful, the mission was still a remarkable achievement. The orbiter continues to orbit the Moon and has provided valuable data on the lunar surface, atmosphere, and exosphere. Chandrayaan-2 has also inspired a new generation of scientists and

[15] www.jagranjosh.com

engineers in India. The mission showed that India could achieve great things in space, and it encouraged many young people to pursue careers in space science and technology.

4.3 Chandrayaan-3:

The failed landing of Chandrayaan-2 was a teaching experience which ultimately led to the success of Chandrayaan-3[16]. Chandrayaan-3 carried a suite of 13 scientific instruments, including both Indian and international payloads. The lander's instruments were used to study the lunar surface composition and structure, and its environment. The rover's instruments were used to study the lunar surface topography, mineralogy, and elemental composition, and to map the lunar ice distribution.

Figure-3: Chandrayaan-3[17]

The Chandrayaan-3 mission is significant for a number of reasons-

First, it is India's first attempt to soft-land a rover on the Moon. It made India the fourth country to do so, after the United States, Russia, and China.

Second, Chandrayaan-3 is the first mission to explore the lunar South Pole in over 40 years. The South Pole is of particular interest to scientists because it is believed to contain significant amounts of ice, which could be used as a resource for future lunar missions. his belief turned into truth with findings of water ice on the lunar surface by Chandrayaan-3.

Third, Chandrayaan-3 carried advanced scientific instruments that provided new insights into the Moon's composition, structure, and environment. This data helps scientists to better understand the Moon's formation and evolution, and to identify potential landing sites for future missions.

Earlier in the month of July, scientists put the rover to sleep as the sun began to set on the Moon. The lander rover was unable to function as it needed sunlight to charge its batteries. The country's space research agency ISRO said it hoped that they would reawaken "around 22 September" when the next lunar day breaks. ISRO has provided regular updates on their movements and findings

[16] Chandrayaan-3 is a follow-on mission to Chandrayaan-2 to demonstrate end-to-end capability in safe landing and roving on the lunar surface.

[17] Figure-1 this photo was uploaded by isro on its official website www.isro.gov.in

along with shared images taken by them. These updates have excited many Indians, but others have been asking about the significance of these discoveries. Hours before the rover was put to bed on the 2nd of September, ISRO said Pragyaan "has traversed over 100m [328 feet] and is continuing".

That's quite a long way to travel for the six-wheeled rover, which moves at a speed of 1 cm per second. The BBC asked Mila Mitra, a former Nasa scientist and co-founder of STEM and Space, a Delhi-based space education company, to pick out some of Chandrayaan-3's major findings and explain their significance. The rover, she says, has a special wheel mechanism - called a rocker bogie - which means that all its wheels don't move together, helping it traverse up and down, but it may not be able to climb out if it falls into a deep crater. So it's important to make it go around the craters or even retrace its steps. And that, Ms. Mitra adds, is done by scientists at the command center who are "watching the Moon through the rover's eyes". "The rover is not automated and its movements are controlled from the command center which acts on the basis of the pictures it sends. ''There's a slight delay before they reach the command center because of the circuitous route they take - Pragyaan sends them over to the lander which sends them on to the orbiter to pass them on to Earth."

5. Output Achieved:

The Chandrayaan-3 mission had the life of one lunar day (14 Earth days) and since that period ended, both the lander and the rover have been put to sleep as the lunar night rages on. ISRO scientists are hopeful that Vikram and Pragyan will wake up on the Moon soon. Regardless of what happens, the Chandrayaan-3 mission has already made great strides in terms of science. Here's a look at everything Chandrayaan-3 has managed to achieve on the Moon's south pole region so far.

(i) **Discovery of elements:** Prayag rover found many vital minerals on the Moon surface including iron, calcium, titanium, oxygen, alumina, silicon etc.

(ii) **Soft landing:** The lander made a successful soft landing on the moon's surface, making India the first country to reach close to the lunar south pole.

(iii) **Temperature data:** The mission provided data on the temperature on the moon, which is around 10 degrees Celsius near the surface and minus 60 degrees Celsius 8 cm below the ground.

(iv) **Navigation, guidance, and control:** The mission included a powered descent trajectory design and associated software elements.

All the modules of Chandrayaan-3 were designed to survive one lunar day, or 14 Earth days. The Pragyan rover was put into sleep mode on September 2 after traversing over 100 meters on the lunar surface. The mission was scheduled to snooze until September 22, when it was hoped, the machines would return to duty. However, the mission did not wake up again. ISRO said it has

received no signals from the Vikram lander and Pragyan rover. It seems like the mission instruments have not survived the lunar night.

6. Conclusion:

In conclusion, the successful landing of Chandrayaan-3 on the Moon's surface marks a defining moment in India's journey of space exploration. This achievement showcases the nation's scientific prowess, determination, and unwavering commitment to pushing the boundaries of human knowledge. The mission's success not only adds a new chapter to India's space history but also propels the country into a new era of possibilities and advancements in space technology. The Chandrayaan-3 mission has also shown India's scientific prowess and commitment to pushing the boundaries of human knowledge. It could also usher in a new era of economic growth, job creation, and technological innovation. (www.sscnr.net.in)

References:

- **Aryabhatta (page 14)** :was India's first satellite, named after the astronomer. It was launched on 19 April 1975
- **Chandrayaan-1 (page 15)** was the first Indian lunar probe under the Chandrayaan programme. It was launched by the Indian Space Research Organisation (ISRO) in October 2008.
- **Vikram and pragyan (page 16)**Chandrayaan-1 had a lander vikram and a rover pragyan www.indiatimes.com
- **Chandrayaan 2 (page 17)**Mission was launched from the Satish Dhawan Space on July 22, 2019, by GSLV Mk III-M1. The main aim of Chandrayaan 2 was to trace the location and abundance of lunar water on the moon's surface.
- **Chandrayaan-3(page 19)** is a follow-on mission to Chandrayaan-2 to demonstrate end-to-end capability in safe landing and roving on the lunar surface.
- **The Department of Space (DOS) (page 14)** has the primary objective of promoting development and application of space science and technology to assist in all-round development of the nation.
- **INSAT or the Indian National Satellite System(page 14)** is a series of multipurpose Geo-stationary satellites launched by ISRO to satisfy the telecommunications, broadcasting, meteorology, and search and rescue needs of India.
- **ISRO (page 14)** The Indian National committee for Space Research was established in 1962
- **The National Aeronautics and Space Administration (NASA),** US. https://www.nasa.gov
- **The Terrain Mapping Camera (TMC) (page 16)** on India's first satellite for lunar exploration, Chandrayaan-1, is for generating high-resolution 3-dimensional maps of the Moon. www.springer.com