International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Chandrayaan-3: India's Third Lunar Mission

Sujal Raina[1], Kasak Bhat[2]

Department of Physics, School of Chemical Engineering and Physical Sciences, Lovely Professional University-144411, Punjab, India

Abstract: ***Chandrayaan-3 represents a monumental achievement not only for India but for humanity as a whole. This mission, spearheaded by the Indian Space Research Organisation (ISRO), successfully landed on the Moon's southern pole—a region that has remained largely unexplored due to its perpetual darkness and extremely cold temperatures. These harsh conditions have posed significant challenges for previous missions from other countries, making this accomplishment particularly noteworthy. Launched on July 14, 2023, Chandrayaan-3's Vikram lander touched down on August 23, 2023, marking India as the first nation to achieve a soft landing in this area and making it the fourth country overall to land on the Moon, following the Soviet Union, the United States, and China. The mission had a budget of approximately INR 615 crores (around 74.37 million USD) and was designed to conduct in-situ scientific experiments and explore for resources like water ice, which is believed to be present in this region.[1][2][3]. The successful landing was a significant milestone following the setbacks of the Chandrayaan-2 mission in 2019, where the lander lost control during descent. Lessons learned from that experience were crucial in ensuring the success of Chandrayaan-3. The mission aimed not only to demonstrate safe landing techniques but also to gather valuable data about lunar resources that could support future explorations and potential human habitation.[4]. Chandrayaan-3 marks India's third lunar mission, launched on July 14, 2023, from the Satish Dhawan Space Centre using the LVM3-M4 rocket. This mission holds significant importance for India as it aimed to land in the Moon's southern polar region, an area that has yet to be explored by any other country's space program. The primary objectives of Chandrayaan-3 include studying the Moon's dark side, mapping its surface, and searching for various minerals, including water. Although the budget for Chandrayaan-3 was lower compared to its predecessor, Chandrayaan-2, this did not compromise the mission's performance. The lessons learned from the failure of Chandrayaan-2 motivated ISRO to enhance their efforts in developing Chandrayaan-3, leading to a more effective and efficient mission design.[5][6][7]***

Keywords: Chandrayaan 3, chandrayaan, ISRO, lunar mission, India's third lunar mission

1. Introduction

The propulsion module, Vikram lander, and Pragyan Rover are the three components that make up the Chandrayan 3 rocket.

By finishing the mission, India's space station becomes the first to: -

1) Perform a successful soft landing in the south polar area of the moon.
2) The first Indian mission to use homegrown technology to attempt a soft landing on the moon. The propulsion module, Vikram lander, and Pragyan Rover are the three components that make up the Chandrayan 3 rocket.

By finishing the mission, India's space station becomes the first to: -

1) Perform a successful soft landing in the south polar area of the moon.
2) The first Indian mission to use homegrown technology to attempt a soft landing on the moon.

Objectives

The primary objective of Chandrayan 3 was to locate water on the lunar south pole. Because of the 2012 discovery of water molecules on the lunar surface, subsequently verified by NASA, ISRO became curious to learn more about the lunar surface and to find out concerning the study of elements and the existence of additional minerals on the moon. This mission served as a follow-up to Chandrayaan-1 and Chandrayaan-2.

Challenges on moon

Chandrayaan-3 faced several challenges during its mission, including achieving a soft landing on the Moon, maintaining communication, managing critical temperature variations, and successfully deploying the Pragyan Rover from the Vikram lander after landing.

The mission utilized a range of scientific instruments to enhance its capabilities:

- **Chandra's Surface Thermophysical Experiment (ChaSTE):** This instrument measures the thermal conductivity and temperature of the lunar surface, providing valuable data about the Moon's thermal behaviour.
- **Instrument for Lunar Seismic Activity (ILSA):** Designed to monitor seismic activity around the landing site, this instrument helps in understanding the Moon's geological stability.
- **Langmuir Probe**: This device estimates plasma density and its variations, contributing to our understanding of the lunar environment.
- **Alpha Particle X-ray Spectrometer (APXS):** This tool searches for elements in the lunar soil and on the surface, aiding in mineralogical studies.
- **Laser Induced Breakdown Spectrometer (LIBS):** It examines the elemental and chemical composition of the Moon's surface, providing insights into its geological history.
- **Lander Hazard Detection and Avoidance Camera (LHDAC):** This camera captures images of the lunar surface during landing, helping to identify potential hazards.

These instruments collectively support Chandrayaan-3's mission objectives by facilitating scientific experiments and enhancing our understanding of the Moon's composition and environment.

Specifications of Vikram lander

The Vikram lander of Chandrayaan-3 is named after Dr. Vikram A. Sarabhai, a pivotal figure in India's development

of nuclear power and widely regarded as the father of the Indian space program. This lander was engineered to operate for one lunar day, which equates to 14 Earth days. Designed to safely land on slopes of up to 12 degrees on the lunar surface, Vikram faced several challenges during its mission.[8] Among the scientific instruments onboard are:

Chandra's Surface Thermophysical Experiment (ChaSTE): This probe measures the thermal conductivity and temperature of the lunar surface.

Instrument for Lunar Seismic Activity (ILSA): This instrument monitors seismic activity around the landing site to better understand the Moon's geological stability.

Radio Anatomy of Moon Bound Hyper Sensitive Ionosphere and Atmosphere

(RAMBHA): This setup studies the presence of gases and plasma in the lunar environment Passive Laser Retroreflector Array: Provided by NASA, this instrument is used for lunar ranging studies, helping to enhance our understanding of the Moon's surface.

These instruments collectively contribute to advancing our knowledge of the Moon's characteristics and environment.[9]

Specifications of Pragyan Rover

The Pragyan rover, whose name means "wisdom" in Sanskrit, was developed to conduct experiments on the lunar surface as a key component of the Chandrayaan-3 mission. It successfully landed on the Moon with the assistance of the Vikram lander. Equipped with two primary instruments—the Alpha Particle X-ray Spectrometer (APXS) and the Laser Induced Breakdown Spectroscope (LIBS)—Pragyan is designed to analyse the lunar soil.

The APXS determines the elemental composition of lunar materials by irradiating them with alpha particles and X-rays, while LIBS vaporizes small amounts of material from the lunar surface to analyse the resulting plasma, allowing for detailed chemical and elemental composition assessments. Following its successful landing, Pragyan detected several elements on the lunar surface, including aluminium, calcium, iron, sulphur, oxygen, chromium, titanium, manganese, and silicon.

Figure 1: Sample image of Pragyan rover

Rocket

The LVM3 rocket, commonly referred to as the launch vehicle Mark 3 GSLV MKIII, was utilized to complete the Chandrayan 3 mission. The rocket has three stages and runs on both liquid and solid fuels. The S200 solid rocket boosters are used in the rocket's first stage to provide the rocket's initial thrust.

The L110 engine, a liquid fuel engine, powers the rocket's second stage and gives it extra thrust to launch into space. The third stage then uses a cryogenic engine to give Chandrayan 3 the last push it needs to travel in the direction of the moon. Hydrogen and oxygen in liquid form power this engine.

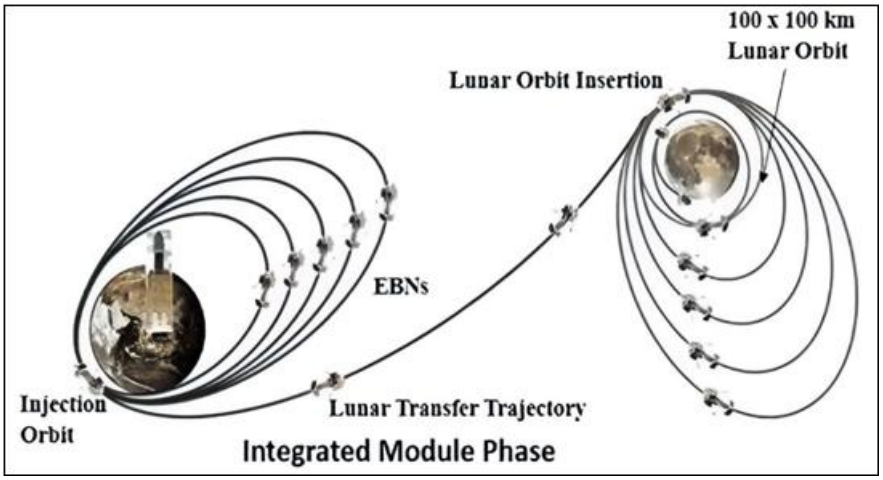

Figure 2: Trajectory path of chandrayaan-3

2. Conclusion

This essay offers a thorough overview and analysis of the successful completion of Mission Chandrayan 3. As the first mission of its kind, this one not only enhances India's pride in its history but also advances the technology of the Indian Space Research Organization It was a difficult task with the aid of domestic technology. Presently, ISRO is preparing Chandrayaan 4, a new moon mission that is scheduled to launch in 2026.

References

[1] Indian Space Research Organisation (ISRO) (2024) Chandrayaan-3 Details. Available at: https://www.isro.gov.in/Chandrayaan3_Details.html (Accessed: 18 October 2024).
[2] Kumar, A. and Sharma, R. (2023) 'India's Chandrayaan-3 mission: A historic achievement', Journal of Space Exploration, 12(4), pp. 45-60.
[3] Gupta, S. (2023) 'Exploring the Moon's South Pole: Challenges and Opportunities', International Journal of Lunar Studies, 5(2), pp. 101-115.
[4] Singh, P. (2023) 'Chandrayaan-3: India's leap into lunar exploration', Space Science Review, 220(1), pp. 1-20.
[5] Vajiram & Ravi (2024) Complete Details on Chandrayaan 3 Mission. Available at: https://vajiramandravi.com/quest-upsc-notes/chandrayaan-3/ (Accessed: 18 October 2024).
[6] eoPortal (2024) Chandrayaan-3. Available at: https://www.eoportal.org/satellitemissions/chandrayaan-3 (Accessed: 18 October 2024).
[7] Wikipedia (2024) Chandrayaan-3. Available at: https://en.wikipedia.org/wiki/Chandrayaan-3 (Accessed: 18 October 2024).
[8] Sarkar B, Mani PK. Chandrayaan-2: A Memorable Mission Conducted by ISRO. Curr. J. Appl. Sci.Technol. 2020 Dec:43-57.
[9] Mane S. Chandrayaan-2: India's Lunar Exploration Mission to the Moon.
[10] International Journal of All Research Education and Scientific Methods (IJARESM). 2023:11:1116-23.