

“Mission Chandrayaan-2”

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Objective : The Chandrayaan-2, India’s ambitious mission to soft land on the south pole surface of the moon.

Aim : Through this mission, ISRO aim to,

- 1) Expand India’s footprint in space.
- 2) To inspire a future generation of scientists, engineers, and explorers.
- 3) Surpass international aspirations.

Components : 1) Orbiter- will orbit at an altitude of 100km

2) Vikram Lander- will touch down on lunar surface and release the rover

3) Pragyan Rover- will move at a speed of 1cm per second and cover total distance of 500 meters



Fig1: Pragyan isRover ramp of the Vikram Lander in clean room

Chandrayaan-2 will carry 14 payloads in all of these 13 are Indian. 8 on the orbiter, 3 on lander, 2 on the rover and the lander have 1 NASA payload

Methods : GSLV MK-III

The 3.8 ton Integrated module comprising the orbiter, lander and rover will be launched by India’s most powerful rocket the GSLV MK-III.

Project Cost : The total cost was 978 crore which includes 603 crore for the space segment and 375 crore as launch costs on GSLV MK III.

Findings : Chandrayaan-2 has several science payloads to expand the lunar scientific knowledge through detailed study distribution, surface chemical composition, thermo-physical characteristics of top soil and composition of the lunar atmosphere, which leads to a better understanding of the origin and evolution of the Moon.

Abstract : Chandrayaan-1 launched on 22 october 2008 which was India’s first mission to moon using the Polar Satellite Launch Vehicle(PSLV-CII). Chandrayaan-1 discovered the presence of hydroxyl(OH) and water(H₂O) molecules on the lunar surface of the moon.

Chandrayaan-2 aimed to improve India’s understanding of the moon and the deep-space mission which is a promising test bed to demonstrate technologies and to increase understanding of space, promote the advancement of technology for the generation.

1. INTRODUCTION

Chandrayaan-2 is on a mission unlike any before. It’s nearly a decade of scientific research and engineering development. The south polar region of Moon, it’s a completely unexplored section of the moon on which India’s second lunar expedition will shed the light on. This mission will help us gain a better and a precise understanding of the origin and evolution of the moon by conducting the topographical studies, comprehensive mineralogical analyses, and a host of other experiments on the lunar surface. While there, this mission will also explore the discoveries that has made by chandrayaan-1, such as the presence of hydroxyl and water molecules on the moon and new rock types with different chemical composition.



Fig 2: view of the majestic lift-off of GSLVMK-III carrying Chandrayaan-2

India's Geosynchronous Satellite Launch Vehicle, GSLV MKIII-M1 has successfully launched Chandrayaan-2 spacecraft at 2:43 PM IST on July 22, 2019 into its planned orbit with a perigee (nearest point to Earth) of 169.7 km and an apogee (farthest point to Earth) of 45,475 km. The launch took place from the Second Launch pad at Satish Dhawan Space SHAR, Sriharikota. After the injection of Chandrayaan-2 spacecraft, a series of maneuvers will be carried out to raise its orbit and put Chandrayaan-2 on Lunar Transfer Trajectory. On entering Moon's sphere of influence, on-board thrusters will slow down the spacecraft for lunar capture. The orbit of Chandrayaan-2 around the moon will be circularized to 100x100 km orbit through a series of orbital maneuvers. On the day of landing, the lander will separate from the orbiter and then perform a series of complex maneuvers comprising of rough braking and fine braking. Imaging of the landing site region prior to landing will be done for finding safe and hazard-free zones. The lander-vikram will finally land near South Pole of the moon on Sep 7, 2019. Subsequently, Rover will roll out and carry out experiments on Lunar surface for a period of 1 Lunar day which is equal to 14 Earth days. Orbiter will continue its mission for a duration of one year.

2. Why the Moon's South Pole?

Many countries, companies and the individuals over world are trying to fly their flags on the lunar south pole surface of Moon.

1. Its craters have been untouched by sunlight for billions of years-offering an undistributed record of the Solar System Origins.
2. Its permanently shadowed craters are estimated to hold nearly 100 million tons of water.
3. Its regolith, the layer of unsolidated solid material covering the bedrock has traces of hydrogen, ammonia, methane, sodium, mercury, and silver-making it an untapped source of essential resources.
4. Its elemental and positional advantages makes it a suitable pit stop for future space exploration.

2.1 Celestial Relation

As we know that the history has been shared between the Earth and the Moon which will affect each other on a daily basis.

1. Earth's gravitational pull is the reason we only see one side of the Moon creating a phenomenon called tidal locking.
2. Just as a tightrope walker uses their stick to keep balance, the Moon's gravity also offsets Earth's oblique orbit.
3. Earth's gravity causes tremors and other seismic activities on the Moon called Moon-quakes and even shifts physical structures on its surface.
4. High and low tides are aligned with the pull Moon exerts on the Earth at its apogee and perigee.

3. Journey to Moon

1. GSLV MK-III carrying Chandrayaan-2 spacecraft weighing 3,290 kg has launched from Sriharikota on July 23. This spacecraft GSLV MK-III will carry an orbiter, a rover and a lander to the moon. Rover has been designed in such a way that it will have power to spend a Lunar day or 14 Earth days on Moon's surface. Rover will send data and images of moon back to Earth via the orbiter in 15 minutes.
2. Once GSLV MK-III reaches GTO, it will put spacecraft in 170kmx20,000km elliptical orbit.
3. Orbiter will reach moon's orbit in over a month Moon's orbit is 3,82,000km away from Earth's surface
4. After reaching Moon's orbit, lander will get detached from orbiter and do a soft-landing near south pole of Moon, which has big rocks that are billions of years old.
5. Six-wheeled rover fixed within lander will get detached and move on the lunar surface.

3.1 Day to day updates

1. The Chandrayaan-2 carried by GSLV MK-III has launched on July 23, 2019 from Sriharikota.
2. Chandrayaan-2 carries out first orbit raising maneuver around the earth on July 24, 2019.
3. The Chandrayaan-2 carries out second orbit raising maneuver around the earth on July 25, 2019.
4. The Chandrayaan-2 carries out third orbit raising maneuver around the earth on July 29, 2019.
5. Chandrayaan-2 completed its fourth orbit raising maneuver around the earth on August 2, 2019.
6. The fifth and final orbit raising maneuver for Chandrayaan-2 spacecraft has been carried out on August 6, 2019 at 1504 hrs IST.
7. Trans Lunar Insertion (TLI) maneuver was performed on August 14, 2019 at 0221 hrs IST as planned and will depart from Earth's orbit and move towards the Moon.
8. On August 20, 2019 after the Lunar Orbit Insertion (LOI) Chandrayaan-2 is now in Lunar orbit.

9. Second Lunar bound orbit maneuver for Chandryan-2 spacecraft was performed successfully on august 21, 2019.
10. Third Lunar bound orbit maneuver for Chandrayaan-2 spacecraft was performed successfully on august 28, 2019 beginning at 0904 hrs IST, using the onboard propulsion system. The duration of the maneuver was 1190 seconds. The orbit achieved is 179x1412 km
11. The fourth lunar bound orbit maneuver for Chandrayaan-2 was performed on august 30, 2019 at 1818 hrs IST.
12. The final and fifth Lunar bound orbit maneuver for Chandrayaan-2 spacecraft was performed successfully on sept 01, 2019 at 1821 hrs IST.
13. Vikram Lander successfully separates from chandrayaan-2 orbiter on September 02, 2019 at 1315 hrs IST.
14. The first de-orbit maneuver for Vikram lander of Chandrayaan-2 spacecraft was performed successfully on September 03, 2019 at 0850 hrs IST.
15. On September 7, 2019 around 1:40 AM not only India but the whole world watched its progress but unfortunately ISRO losses communication with Vikram Lander during the final phase of descent on the lunar surface at an altitude of 2.1 kms, Vikram lander went dark and all data communications was lost.

4. Vikram Lander procedure



Fig 3: Vikram lander on moon

ISRO has described the last few minutes of the descent of Vikram lander as terrifying. Chandrayaan-2 Vikram Lander begins the procedure of soft landing at around 1:40 AM IST on sept 7, 2019. The landing will take around 15 terrifying minutes for ISRO. The entire process will involve a series of critical and crucial maneuver such as rough braking and fine braking. In order to land the Vikram Lander module the predefined location very high precision and accuracy are required. Even a minute mistake can lead to the failure of the lunar surface of the exploration part of the machine. Just 5 months back in april 2019 Israel attempt to make a soft landing on the moon and ended in failure. His spacecraft was unable to slow down sufficiently enough and crash landed on the moon. The on-board camera of Vikram lander to look for the right location once the location identified based on the predefined parameters the 5 rocket engines of the lander will precisely control the lander the rockets will first reduce the speed and then make the lander virtually float at predefined landing point.

The cameras laser ranging systems on-board computers and above all software requirement for the entire operation has to work in unison. At the time it became the descent Vikram would be travelling at about 6km per hour that is about 30 to 40 times the average speed of communication airlines, which usually travels at the speed between 500 to 900km per hour within 15 minutes Vikram speed to be brought down to 2 meters per second or about 7km/hour allowed to enable a safe landing. During the rough braking phase which will be conducted at an altitude of about 100km above the lunar surface, the four engines on the four side of cubical will be used. This will slow down the orbital velocity of the lander.

The on-board lander position detection camera of Vikram lander will switched on to identify perfect location for a safe landing on the lunar surface the location needs to be a flat lunar surface to help the lander to sit perfectly on the ground. The two engines of the Vikram lander will be ignited at this perfect stage almost 400m above the moon surface at an altitude of just 10 meters above the lunar surface, ISRO will carry out a parabolic descent of the Vikram lander of the soft landing. During this process ISRO will ignite a new central engine and perform a comfortable landing using the touch down sensor placed at the bottom of the stands.

After the successful touch down three payloads namely the Chaste, Rambha and Ilsa will be diploid the Vikram lander. Chaste which is located at the lower edge of the cubical Vikram lander will extend just like one of its stand touching the ground. The Rambha payload located at the upper side of the outer wall of the lander will extend like a roll while the third payload Ilsa is located at the bottom. The Vikram lander is fitted with solar panels on its outer walls. They will be used for power generation for the project. The rover pragyan which is housed inside the lander walks on the moon 4 hours after Vikram lands, rover pragyan will start exploring moon surface. Six wheeled robotic vehicle will travel at a speed of 1cm per second and cover 500 meter. It will carry experiments for one lunar day which is equal to 14 Earth days.

5. What went wrong with Vikram lander during final stage?

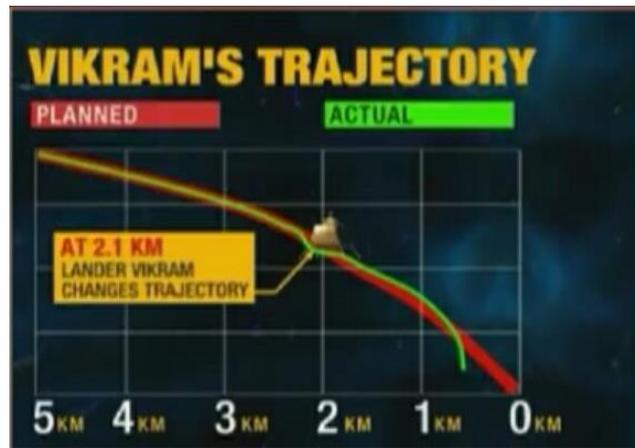


Fig 4: Vikram descent trajectory

Two critical phases even after the power descent started;

1. Rough braking phase

The rough braking phase was initiated around 1:39 AM on September 7 to reduce the Vikram lander's speed from 21,600 km/hour to 7 km/hour for safe landing. It had a hard-landing very close to the planned site as per the images sent by the on-board camera of the orbiter. The lander is there as a single piece, not broken into pieces, it's in a tilted position, according to a senior ISRO official associated with the mission.

2. Fine braking phase

It is the time when the robot started to deviate from the actual trajectory and just 2.1 km above the lunar surface the communication was lost.

From some resources it has been said that ISRO lost Chandrayaan-2 lander Vikram contact at just 400 meters above Moon, not 2.1 kms. And it has been confirmed by ISRO that Chandrayaan-2 orbiter will now remain operational for seven years.

Even NASA helping ISRO to establish communication with lander Vikram. It has been reported that NASA Jet Propulsion Laboratory (JPL) is sending radio signal to Vikram lander and attempts are being made to reestablish communication link with the moon lander Vikram.

ISRO: Till 2.1 km it was all normal the mission faced the snag and the mission agency is still analyzing data and 95% mission has been successful, says ISRO

PM Mr. Narendra Modi on ISRO: He asked ISRO scientists not to get disheartened by the hurdles in the moon mission Chandrayaan-2 and asserted that there will be a "new dawn and better tomorrow".

The nation was proud of them and stood with them, he said. "We came very close but we need to cover more ground in the times to come. Learning from today will make us stronger and better. The nation is proud of our space program and scientists. The best is yet to come in our space program. There are new frontiers to discover and new places to go. India is with you," Mr. Modi said. "Effort was worth it and so was the journey. It will make us stronger and better. There will be a new dawn and better tomorrow... I am with you, nation is with you," he added.

NASA on ISRO: Space is hard. We commend @ISRO's attempt to land their #Chandrayaan2 mission on the Moon's South Pole. You have inspired us with your journey and look forward to future opportunities to explore our solar system together.

5. CONCLUSION

ISRO loses communication with Vikram lander still it is a very big achievement accomplished by India and India is the first country attempting to land a mission on the lunar south pole of moon and it's the fourth overall after the United States, Russia and China to conduct a soft landing on the lunar surface. Now India is the first country to land on the southern pole of the moon. It not only carries a lunar rover, but also the hopes and dreams of a billion Indians. We are proud of all the scientists of ISRO and a very big congratulations to team ISRO.

Chandrayaan-1: Found water molecules on the moon

Chandrayaan-2: Attempted soft landing

Chandrayaan-3: We won't give up

We have already created history hope we can communicate Vikram Lander soon JAI HIND.

REFERANCES

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