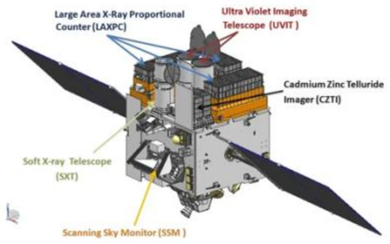
AstroSat:

Purpose: India's first dedicated multi-wavelength space observatory. It observes the universe in optical, ultraviolet, low and high energy X-ray regions of the electromagnetic spectrum.



- To understand high energy processes in binary star systems containing neutron stars and black holes.
- Estimate magnetic fields of neutron stars.
- Study star birth regions and high energy processes in star systems lying beyond our galaxy.
- Detect new briefly bright X-ray sources in the sky.
- Perform a limited deep field survey of the Universe in the Ultraviolet region.

Launch: Launched in 2015.

Achievements:
1. **Multi-wavelength Observations**: Enabled simultaneous multi-wavelength observations of various astronomical phenomena.
2. **Discovery**: Detected a special class of stars in the NGC 2818 cluster and a supernova in the NGC 660 galaxy.
3. **International Recognition**: Observations from AstroSat have been cited and acknowledged in various international scientific journals.

Mars Orbiter Mission (MOM):

Purpose: Also called Mangalyaan, it was India's first interplanetary mission, aiming to demonstrate technology and conduct Mars surface imaging.
Launch: Launched in 2013.

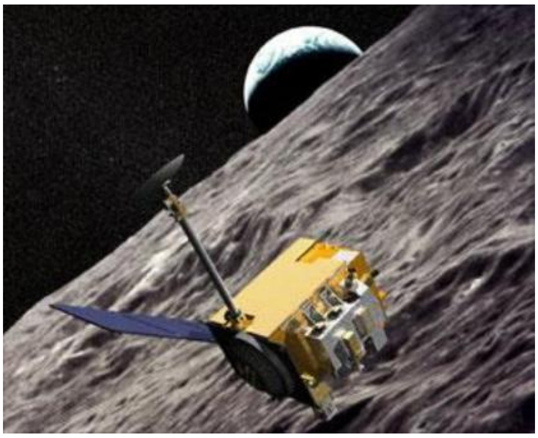
Achievements:
1. **First Attempt Success**: India became the first Asian nation to reach Martian orbit and the first nation globally to do so on its maiden attempt.
2. **Cost-Efficiency**: The mission was hailed for its low operational cost.
3. **Valuable Data**: MOM sent numerous images and data from Mars, increasing our understanding of the Red Planet.
4. **Global Recognition**: MOM's success firmly positioned ISRO on the global space scene as a significant player in interplanetary explorations.

Lunar Missions of ISRO

Chandrayaan-1:

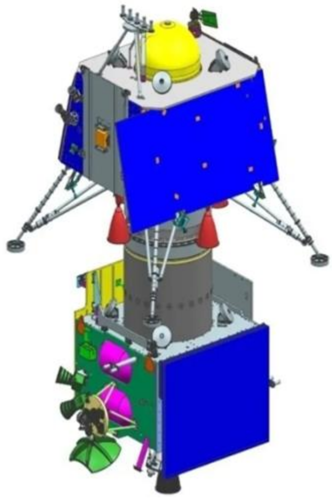
Purpose: India's first mission to the Moon to understand the lunar surface better with an orbiter.

Launch: Launched in 2008.
Achievements:



1. **Water Molecules Discovery**: Helped in confirming the presence of water/hydroxyl on the Moon.
2. **Confirmed ocean magma hypothesis**
3. **Spinel** rich rock
4. Found Magnesium, Silicon, Aluminium
5. **High-Resolution Remote Sensing**: Produced a high-resolution chemical, mineralogical and photo-geologic map of the lunar surface.
6. **Lunar Atlas**: The data from the mission helped in the creation of the 'Atlas of the Moon', detailing different types of lunar surfaces.

Chandrayaan-2:

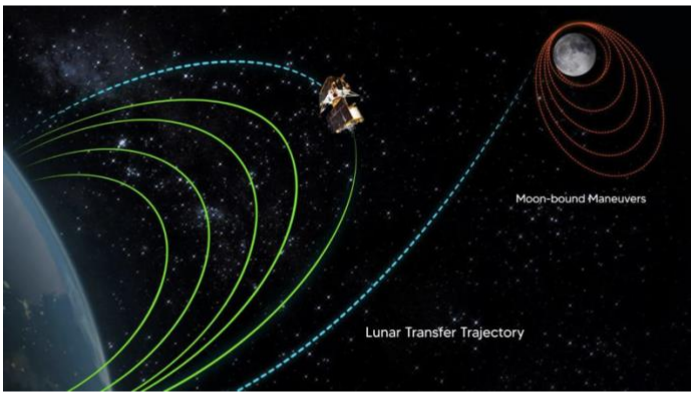


Purpose: A follow-up to Chandrayaan-1, it included an orbiter, a lander named Vikram, and a rover named Pragyan. Lander couldn't successfully soft land.
Launch: Launched in 2019.
Achievements:

1. **Orbiter Success**: While the lander Vikram crash-landed on the lunar surface, the orbiter successfully entered lunar orbit and is expected to operate for many years.
2. **Lunar Surface Imaging**: The orbiter's cameras and sensors have been providing high-resolution images and data on the Moon's surface.
3. **Ice Detection**: Chandrayaan-2's instruments have detected ice and identified minerals on the lunar surface.
4. **Have fund** Argon – 40, Chromium, Manganese
5. Impact of **Solar flare on lunar surface**

Chandrayaan - 3

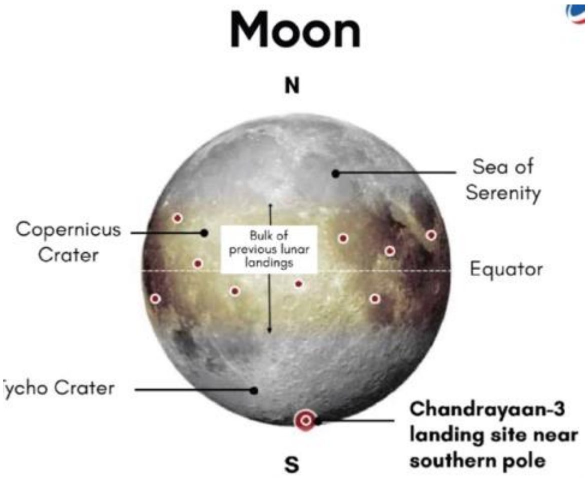
- indigenous Lander module (LM), Propulsion module (PM) and a Rover with an objective of developing and demonstrating new technologies required for Inter planetary missions



- **Launched from LVM-3**
- **Chandrayaan-3 lander accomplished a 'soft landing' near the Moon's South Pole.**
- India became the fourth country to successfully land on moon after US, Russia and China.
- Japan has become the fifth country to achieve it with Smart Lander for Investigating Moon (SLIM).

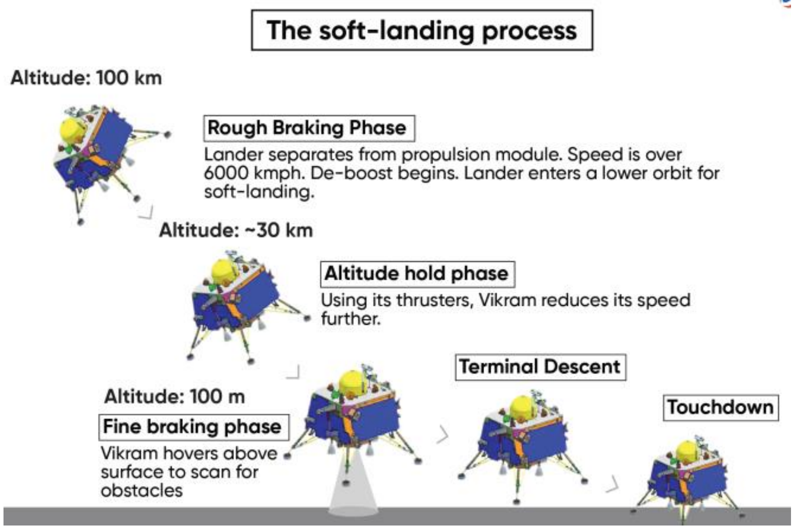
The mission objectives of Chandrayaan-3:

1. To demonstrate Safe and Soft Landing on Lunar Surface
2. To demonstrate Rover roving on the moon and
3. To conduct in-situ scientific experiments.

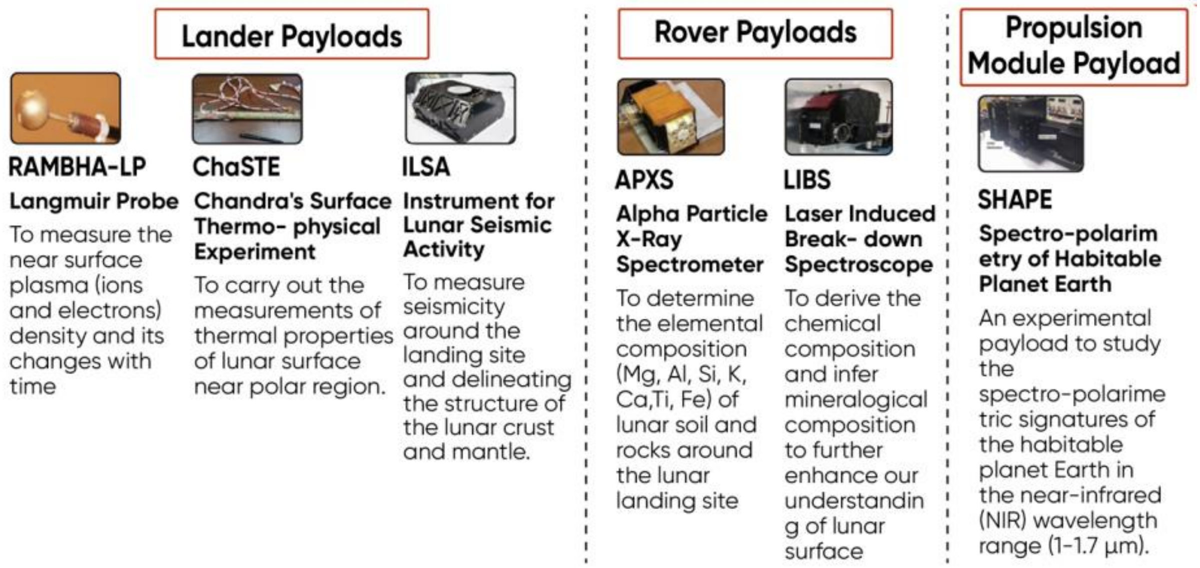


To achieve the mission objectives, several advanced technologies were used in Lander such as,

1. Altimeters: Laser & Radio Frequency based Altimeters
2. Velocimeters: Laser Doppler Velocimeter & Lander Horizontal Velocity Camera
3. Inertial Measurement: Laser Gyro based Inertial referencing and Accelerometer package
4. Propulsion System: 800N Throttleable Liquid Engines, 58N attitude thrusters & Throttleable Engine Control Electronics
5. Navigation, Guidance & Control (NGC): Powered Descent Trajectory design and associate software elements
6. Hazard Detection and Avoidance: Lander Hazard Detection & Avoidance Camera and Processing Algorithm
7. Landing Leg Mechanism.



The objectives of scientific payloads:



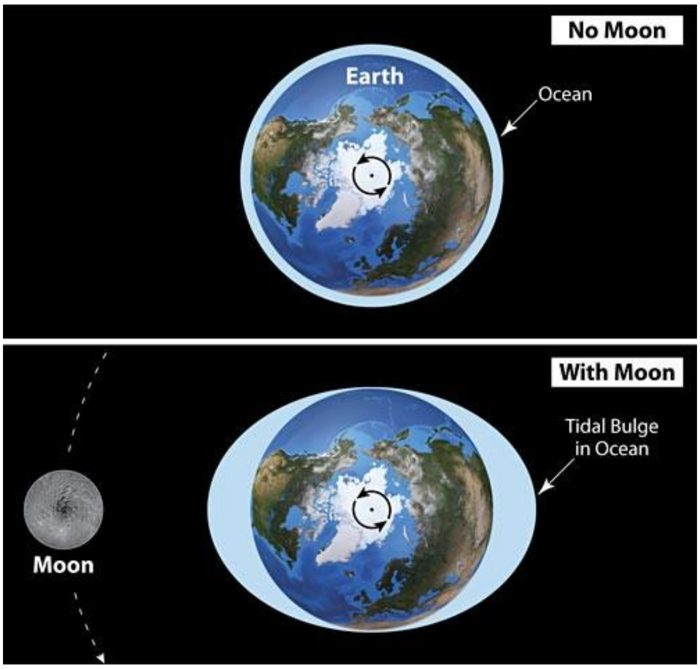
Tidal Forces

Tidal forces arise from the **differential** gravitational pull exerted by a celestial body (like the Moon) on different parts of another object (like the Earth).

- **Gravity weakens with distance**. This means the side of an object closer to the source of gravity experiences a stronger pull compared to the side facing away.
- **The Stretch:** In the case of the Earth and the Moon, the Moon's gravity pulls stronger on the side of Earth facing it (bulge) and weaker on the opposite side (another bulge). This creates a stretching effect, trying to distort Earth into a slightly elongated shape.

Effects of Tidal Forces:

- **Ocean Tides:** The bulges cause high tides on the side facing the Moon and the side facing away. As the Earth rotates, different locations experience high and low tides.
- **Solid Earth Deformation:** The solid Earth also experiences tidal bulges, although much smaller than those in the ocean due to its rigidity.



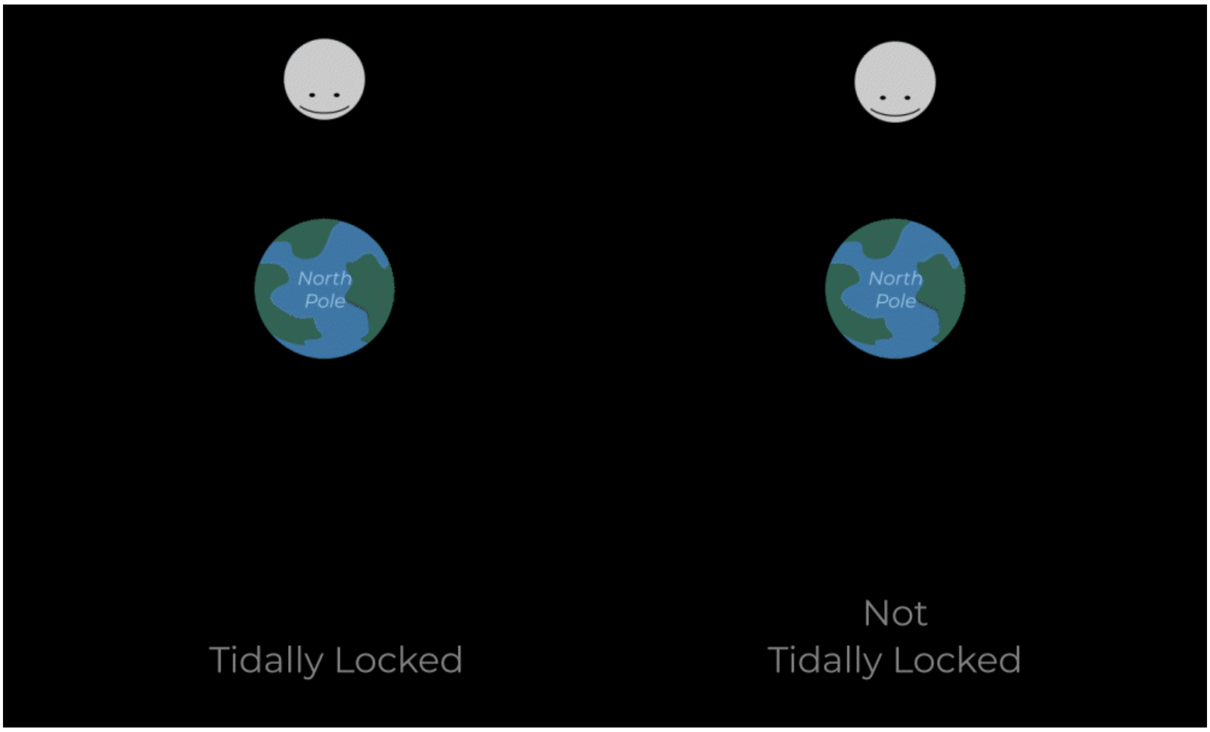
Tidal Locking

Tidal forces can also lead to a phenomenon called tidal locking.

- **Gradual Slowdown:** The tidal bulge on a body (like a moon) creates a slight "gravitational tug" that opposes the body's rotation. Over long periods, this tug can gradually slow down the body's rotation.
- Eventually, the body reaches a point where one side always faces the source of gravity (like the Moon always facing Earth). This is called tidal locking. The body becomes "locked" in its rotation, with one side permanently facing the other body.

Examples of Tidal Locking:

- **The Moon:** The Moon is tidally locked to Earth, which is why we always see the same lunar face. The other side is called dark side of the moon.
  - Synchronization between the Moon’s rotation around its axis (with respect to the Sun) and its orbit around the Earth.
  - That is why moon rotates in about 28 days, the same time it takes to revolve around Earth. Hence, a lunar day and a lunar night are equivalent to 14 days on Earth.
  - **The Chandrayaan-3 mission was solar-powered and its landing coincided with the daylight period on the Moon.**
- **Pluto and Charon:** This dwarf planet and its large moon exhibit a mutual tidal locking, where both bodies always face each other with the same side.



<u>Why Should we Explore Space?</u>

Space exploration offers a range of benefits and motivations that can both indirectly and directly impact life on Earth. Here are some reasons to consider:

1. **Scientific Knowledge**: Exploring other celestial bodies like the Moon or Mars can provide insights into the origin and evolution of our solar system. This can help us understand Earth's past, present, and future better.
2. **Technological Innovation**: The challenges of space exploration have historically led to significant advancements in technology. For instance, technologies developed for space programs have led to advancements in telecommunications, medical imaging, and even water purification.
3. **Economic Opportunities**: The commercial potential of space is vast. From mining asteroids for precious metals to harnessing solar energy in space, there are many opportunities that could lead to economic growth and new industries on Earth.
4. **Planetary Defense**: Studying asteroids and comets can help us protect Earth from potential impacts. We need to understand these objects better to devise ways of diverting or mitigating threats.
5. **Inspiration**: Space exploration has always been a symbol of human curiosity and our desire to push boundaries. It inspires generations to pursue careers in science, technology, engineering, and mathematics (STEM).
6. **Global Collaboration**: International space missions often foster cooperation among nations. Working together in space can lead to better relations on Earth and promote a sense of shared humanity.
7. **Moon-Specific Benefits**:
    - **Gateway to the Solar System**: The Moon can act as a proving ground for technologies and strategies that could be used on longer and more complex missions to Mars and beyond.
    - **Resources**: The Moon contains resources like helium-3, which could potentially be used in future fusion reactors. There's also water ice at the

poles, which can be used for life support and broken down into hydrogen and oxygen for rocket fuel.

8. **Understanding Earth Better**: Studying other planets, especially ones like Mars which might have had conditions similar to early Earth, can give us insights into climate change, geological processes, and even the origins of life.
9. **Human Evolution**: Venturing into space and adapting to other worlds might drive human evolution in unexpected ways, leading to physiological and psychological adaptations.
10. **Survival and Backup**: Earth faces existential risks such as asteroid impacts, super volcanic eruptions, or even potential threats from artificial intelligence. Having a presence on other planets or moons provides a backup.