

# FUTURE MISSIONS OF INDIA

Chandrayaan-3 and Lunar Polar Exploration Mission

Aditya Mission – 2020 – 2021

GGGGGGGGGaganyaan

2022

SHUKRAYAAN

MOM-2

India's Space Station

2019-20 & 2024

2020- 21

2023

2024

## Chandrayaan-3 and Lunar Polar Exploration Mission

In November 2019, ISRO officials stated that a new lunar lander mission was being studied for launch in November 2020; this new proposal is called **Chandrayaan-3** and it would be performed by ISRO alone as a repeat attempt to demonstrate the landing capabilities needed for the **Lunar Polar Exploration Mission** proposed in partnership with Japan in 2024

### CHANDRAYAAN-3

- **Chandrayaan-3** is a planned third lunar exploration mission by Indian Space Research Organisation.
- Chandrayaan-3 will be mission repeat of Chandrayaan-2 and will **only include a lander and a rover similar to that of Chandrayaan-2** and will not have an orbiter.

- Realisation within schedule will make ISRO the **world's fourth space agency to conduct soft lunar landing** after the administration of former USSR, NASA and CNSA.

Chandrayaan-3	
<b>Mission type</b>	Lunar lander, rover
<b>Operator</b>	Indian Space Research Organisation (ISRO)
Spacecraft properties	
<b>Manufacturer</b>	Indian Space Research Organisation (ISRO)
Start of mission	
<b>Launch date</b>	2021
<b>Rocket</b>	GSLV Mark III
<b>Launch site</b>	Satish Dhawan Space Centre
<b>Contractor</b>	Indian Space Research Organisation (ISRO)
Moon lander	
<b>Spacecraft component</b>	Rover
<b>Landing date</b>	Time has not been decided
<b>Landing site</b>	Lunar south pole

## **Lunar Polar Exploration Mission**

- The **Lunar Polar Exploration Mission** is a robotic lunar mission concept by **Indian Space Research Organisation (ISRO)** and **Japan Aerospace Exploration Agency (JAXA)** that would send a **lunar rover and lander** to explore the **south pole region of the Moon in 2024**.
- JAXA is likely to provide the under-development **H3 launch vehicle** and the rover, while ISRO would be responsible for the lander.
- The mission concept has not yet been formally proposed for funding and planning.



## **Aditya-L1 First Indian mission to study the Sun**

A Satellite placed in the halo orbit around the Lagrangian point 1 (L1) of the Sun-Earth system has the **major advantage of continuously viewing the Sun without any occultation/ eclipses**. Therefore, the Aditya-1 mission has now been revised to “Aditya-L1 mission” and will be inserted in a halo orbit around the L1, which is **1.5 million km from the Earth**. The satellite carries **six payloads** with enhanced science scope and objectives.

The project is approved and the satellite will be launched during 2020 timeframe by **PSLV-XL** from Sriharikota.

## **ADITYA- L1 MISSION**

**Position of the satellite:** In order to get the best science from the sun, continuous viewing of the sun is preferred without any occultation/ eclipses and hence, Aditya- L1 satellite will be placed in the halo orbit around the Lagrangian point 1 (L1) of the sun-earth system.

### **What are Lagrangian points and halo orbit?**


Lagrangian points are the **locations in space where the combined gravitational pull of two large masses roughly balance each other.** Any small mass placed at that location will remain at constant distances relative to the large masses. There are five such points in Sun-Earth system and they are denoted as L1, L2, L3, L4 and L5. A halo orbit is a periodic three-dimensional orbit near the L1, L2 or L3.

Aditya-1 was meant to observe only the solar corona. The outer layers of the Sun, extending to thousands of km above the disc (photosphere) is termed as the corona. **It has a temperature of more than a million degree Kelvin which is much higher than the solar disc**

**temperature of around 6000K.** How the corona gets heated to such high temperatures is still an unanswered question in solar physics.

Aditya-L1 with additional experiments can now provide observations of Sun's Corona (soft and hard X-ray, Emission lines in the visible and NIR), Chromosphere (UV) and photosphere (broadband filters). These payloads have to be placed outside the interference from the Earth's magnetic field and could not have been useful in the low earth orbit.

The complete list of payloads, their science objective and lead institute for developing the payload is provided below:

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- **Visible Emission Line Coronagraph (VELC):** – *Indian Institute of Astrophysics (IIA)*
  - **Solar Ultraviolet Imaging Telescope (SUIT):** - *Inter-University Centre for Astronomy & Astrophysics (IUCAA)*
  - **Aditya Solar wind Particle Experiment (ASPEX):** – *Physical Research Laboratory (PRL)*
  - **Plasma Analyser Package for Aditya (PAPA):** – *Space Physics Laboratory (SPL), VSSC*
  - **Solar Low Energy X-ray Spectrometer (SoLEXS):** – *ISRO Satellite Centre (ISAC)*

- **High Energy L1 Orbiting X-ray Spectrometer (HEL1OS):** - *ISRO Satellite Centre (ISAC) and Udaipur Solar Observatory (USO), PRL*
- **Magnetometer:** To measure the magnitude and nature of the Interplanetary Magnetic Field – *Laboratory for Electro-optic Systems (LEOS) and ISAC.*

## **GAGANYAAN PROGRAMME**

The Union Cabinet has approved the Gaganyaan Programme with demonstration of Indian Human Spaceflight capability to **low earth orbit** for a mission duration ranging from one orbital period to a maximum of seven days.

**ISRO aims to launch its maiden Human Space Mission, Gaganyaan before the 75<sup>th</sup> anniversary of India's independence in 2022.**

It is a first human space flight demonstration targeted to be completed within 40 months from the date of sanction.

*India could potentially become the **fourth country to send a man in space**, after the erstwhile **USSR, the US and China**. India has already completed missions to the moon and Mars.*

**GSLV Mk-III** will be used to carry the orbital module which will have necessary provisions for sustaining a **3-member crew for the duration of the mission.**

Gaganyaan Programme will be a **national effort in collaboration with Industry, Academia and other scientific agencies and laboratories as stake holders along with ISRO.**

- Gaganyaan is an Indigenous crewed orbital spacecraft that is intended ***to send 3 astronauts to space for a minimum of seven days by 2022***, as part of the Indian Human Spaceflight Programme.
- The human ***spaceflight will take 16 minutes to reach the orbit where it will stay for five to seven days.***
- The Indian space agency displayed the **Gaganyaan crew model and orange space suits** at the Bengaluru Space Expo's 6th edition earlier this year. ***The space suits were developed at Vikram Sarabhai Space Centre, Thiruvananthapuram.***
- The **capsule will rotate around the Earth every 90 minutes,**
- ***Rs. 10,000-crore mission will be a turning point in India's space journey.***

ISRO successfully conducted its first 'pad abort test' which seems to be its preparation for the Gaganyaan mission. **The pad 'abort' test or Crew Escape System is a measure for emergency escape** which will assist to pull the crew out from the launch vehicle during the abortion of a mission. The test was

undertaken at the Satish Dhawan Space Centre, Sriharikota. The Pad Abort Test experiments the crew module safe recovery in case of any exigency at the launch Pad.

### **ISRO CONDUCTS PAD ABORT TEST**

- Recently, the ISRO undertook a first '**pad abort test**' significant for a future human space mission. The Pad Abort Test experiments the crew module safe recovery in case of any exigency at the launch Pad.
- PAT (pad abort test) is the first of the test in a series for qualifying **a technology of crew escape system in future relating to a manned mission. Crew escape system is a measure for emergency escape** which assists to quickly pull the astronaut cabin along with crew out to a safer distance from launch vehicle during a launch abort.

**Indian Space Research Organisation (ISRO) and Russia's Roscosmos State Corporation for Space Activities (ROSCOSMOS) have signed an MoU for working jointly on Gaganyaan.**

**According to the MoU, the Indian astronaut is offered a ride by the ROSCOSMOS, a short visit on board Soyuz spacecraft to International Space Station (ISS) in 2022 for a small training mission.**



## **Creation of Gaganyaan National Advisory Council**

Recently, a Gaganyaan National Advisory Council has been created in 2019 with members from different institutions and industries.

## **Human Space Flight Centre (HSFC)**

Human Space Flight Centre (HSFC) is created to carry out the activities related to human spaceflight. **HSFC shall be responsible for the implementation of Gaganyaan.** Project- Which involves mission planning, development of engineering systems for **crew survival in space, crew selection and training and also pursue activities for sustained human space flight missions.** HSFC will take the support of **ISRO centers** to implement the first developmental [crewed] flight.

## **Contribution of DRDO for GAGANYAAN Mission**

ISRO, DRDO sign MoU to provide critical technologies for **Human Space Mission.** Under the agreement, the technological capabilities existing in DRDO labs for defence applications will be customised to meet the requirements of ISRO's human space mission. **DRDO will be providing critical technologies to ISRO such as space crew health monitoring and emergency survival kit, space food, parachutes for the crew module's safe recovery and radiation measurement and protection.**

## Objectives of the Mission

- Enhancement of science and technology levels in the country.
- A national project involving several institutes, academia and industry.
- Improvement of industrial growth.
- Inspiring youth
- Development of technology for social benefit
- Improving international collaboration

## Challenges of GAGANYAAN PROGRAMME

- **Gravity field:** Transitioning from one gravity field to another is tricky. It affects hand-eye and head-eye coordination.
- **Isolation:** In spite of providing well training to astronauts, behavioural issues may crop up. They may encounter depression, sleep and psychiatric disorders, etc.
- **Radiation:** In space stations, astronauts receive over ten times the radiation than what people are subjected to on Earth. It may increase the risk of cancer, etc.
- **Hostile environment:** Space is hostile.
- In addition to lack of gravity and danger of radiation, there is no atmosphere. Human blood starts boiling if there is no pressure.

## **Relevance of a Manned Space Mission for India**

- **Boost to industries:** The Indian industry will find large opportunities through participation in the highly demanding Space missions. Gaganyaan Mission is expected will source nearly 60% of its equipment from the Indian private sector.
- **Employment:** According to the ISRO chief, the Gaganyaan mission would create 15,000 new employment opportunities, 13,000 of them in private industry and the space organisation would need an additional manpower of 900.
- **Technological development:** Human Space flights are frontier field in the science and technology. The challenges the Human Space Flights provide to India, and the benefits accruing from taking up those missions will be very high and will lead to further thrust for technological developments in India
- **Spurs research and development:** It will boost good research and technology development. With a large number of researchers with proper equipment involved, HSF will thrust significant research in areas such as materials processing, astro-biology, resources mining, planetary chemistry, planetary orbital calculus and many other areas
- **Motivation:** Human space flight will provide that inspiration to the youth and also the national public mainstream. It would inspire

young generation into notable achievements and enable them to play their legitimate role in challenging future activities.

- **Prestige: India will be the fourth country to launch human space mission.** The Gaganyaan will not only bring about prestige to the nation but also establish India's role as a key player in the space industry.

### **VYOM MITRA**

It is ISRO's **first woman astronaut**. It will be used for **an unmanned flight of ISRO's GSLV III rocket in December 2020**, which, along with a second unmanned flight in July 2021. Vyommitra, equipped with a head, two arms and a torso, is built to **mimic crew activity inside the crew module of Gaganyaan**.

Attaining launch and orbital postures, responding to the environment, generating warnings, replacing carbon dioxide canisters, operating switches, monitoring of the crew module, receiving voice commands, responding via speech (bilingual).

### **SHUKRAYAAN**

**Shukrayaan-1** (Venus craft) is a proposed orbiter to Venus by the Indian Space Research Organisation (ISRO) to **study the surface and atmosphere of Venus**.

Funds were released in 2017 to complete preliminary studies, and solicitations for instruments have been announced.

If fully funded, **it would be launched after the Mars Orbiter Mission 2** in the early 2020s.

The orbiter, depending on its final configuration, would have a science **payload capability of approximately 100 kilograms with 500 W available power.**

The initial **elliptical orbit around Venus** is expected to have **500 km at periapsis and 60,000 km at apoapsis.**

The three broad research areas of interest for this mission include

- 1. Surface/subsurface features and re-surfacing processes**
- 2. Study the atmospheric chemistry, dynamics and compositional variations**
- 3. Study the atmospheric interaction with solar radiation and solar wind**

### **Potential collaboration with France**

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The space agencies of India (ISRO) and France (CNES) [**National Centre for Space Studies (CNES) (French: Centre national d'études spatiales)**] are holding discussions to collaborate on this mission and **jointly develop autonomous navigation and aerobraking technologies.**

**ISRO agreed to consider the proposal to use a balloon probe carrying 10 kilograms payload to study the Venusian atmosphere at 55 kilometres altitude.**

## **Science payload**

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The science payload would have a **mass of 100 kg** and would consist of instruments from India and other countries.

**As of December 2019, 16 Indian and 7 international payloads have been shortlisted.**

Shukrayaan-1	
Mission type	Venus orbiter
Operator	ISRO
Spacecraft properties	
Manufacturer	ISAC
Launch mass	2,500 kg
Payload mass	~100 kg
Power	500 watts for payload
Start of mission	
Launch date	Proposed: 2023
Rocket	GSLV Mark III
Launch site	SDSC SHAR

Contractor	ISRO
Venus orbiter	
Orbital parameters	
Periapsis altitude	500 km
Apoapsis altitude	60,000 km
Venus atmospheric probe	
Spacecraft component	Aerobot balloon

## Mars Orbiter Mission-2

**Mars Orbiter Mission 2 (MOM-2)**, also called ***Mangalyaan-2*** is India's second interplanetary mission planned for launch to Mars by the Indian Space Research Organisation (ISRO).

As per some reports emerged, the mission was to be an orbiter to **Mars proposed for 2024.**

However, in a recorded interview in October 2019, VSSC director has indicated **possibility of inclusion of a lander and rover.**

In January 2016, **India and France signed** a letter of intent for ISRO and CNES to jointly build MOM-2 by 2020, but by April 2018, France was not yet involved in the mission.

ISRO announced its intent to launch a second mission to Mars at the Engineers Conclave conference held in Bengaluru on **28 October 2014**.

The **Indian government funded MOM-2 in its 2017 budget proposal**, and ISRO is considering whether the best path is to conduct an orbiter/lander/rover mission or to opt for only an orbiter with more sophisticated instruments than those flown on MOM.

The **total science payload mass is estimated at 100 kg**.

One of the science payloads under development is an **ionosphere plasma instrument** named **ARIS**. It is being developed by **Space Satellite Systems and Payloads Centre (SSPACE)**, which is part of the Indian Institute of Space Science and Technology (IIST). **The engineering model and high vacuum test have been completed.**

#### Mars Orbiter Mission 2

Names	MOM 2, <i>Mangalyaan-2</i>
Mission type	Orbiter, lander/rover
Operator	<b>ISRO</b>



Mission duration	1 year (proposed)
Spacecraft properties	
Bus	I-3K
Manufacturer	ISAC
Payload mass	≈100 kg
Start of mission	
Launch date	NET 2024
Rocket	GSLV Mk III
Launch site	SatishDhawan Space Center
Contractor	ISRO

## Keynote: Future Project of India

- After Chandrayaan- 2, the Indian Space Research Organisation (ISRO) will launch another mission to the Sun by launching Aditya-L1 in 2020. **Aditya L1 mission** will study the corona of the Sun, which is the outermost part of its atmosphere. It is 1.5 million kilometres from the Earth. It will always look at the Sun and give analysis of corona because it has a major impact on climate change.

- ISRO has also planning for future **Venus mission**, that is a "burning body with very high temperature". It is an interplanetary mission to Venus will be launched in the next 2-3 years. France is also collaborating with India on its mission to Venus.
- Space station project of India, will also be an extension of the **Gaganyaan project** after its completion by 2022. India is planning to launch its own **space station**. Our space station is going to be **very small**. We will be launching a small module and that will be used for **carrying out microgravity experiments**. The weight of the space station is likely to be **20 tonnes**. A space station is a spacecraft capable of **supporting crew members, designed to remain in space for an extended period of time and for other spacecraft to dock**.