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HISTORY OF SPACE RESEARCH IN INDIA

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INTRODUCTION

India's space exploration efforts are led by the Indian Space Research Organisation (ISRO), a government agency that is counted among the world's top six international space organizations. With a record of over 100 successful space missions, ISRO has a countrywide network that is dedicated to advancing India's space mission.

The roots of India's space program date back to the 1920s, when scientists such as S.K. Mitra, C.V. Raman, and Meghnad Saha began conducting studies. In the 1940s and 50s, India's space program gained nationwide attention, but it wasn't until the 1960s that the country made significant strides in the field, as satellite usage was still in its experimental stage in the US. During this time, India focused on studying Earth's atmosphere, weather predictions, and the magnetic field surrounding the planet's surface.

Under the leadership of Pandit Jawaharlal Nehru, India achieved a major milestone in its space history when scientist Vikram Sarabhai established the Indian National Committee for Space Research (INCOSPAR) with Nehru's support. Just a year later, India conducted its first rocket launch in November of 1963. In 1969, INCOSPAR was transformed into the Indian Space Research Organisation (ISRO). Today, ISRO is a major constituent of the Department of Space (DOS) and is dedicated to using science, engineering, and technology to harness the benefits of outer space for India and mankind. Its various centers and units execute the Indian Space Programme on behalf of the government.

OBJECTIVES OF ISRO

ISRO aims to use space technology for national development and research in space science and planetary exploration.

- Operational flights of SSLV (Small Satellite Launch Vehicle), GSLV (Geo-synchronous Satellite Launch Vehicle), and PSLV (Polar Satellite Launch Vehicle).
- To design, develop and realize the communication and earth observation satellites.
- To design and create new solutions for space transportation.

- To develop navigation satellite systems and the development of satellites for planetary exploration and space science.
- To develop applications for observing the earth more precisely.
- To create a system based on Space for societal applications.
- To come up with appropriate training, education, and capacity building for students interested in space technology.

ISRO boasts several facilities, each dedicated to a specialized field of study in space.

- **Vikram Sarabhai Space Centre (VSSC), Thiruvananthapuram** – The VSSC located in Thiruvananthapuram is the main center for the development of satellite launch vehicles and related technologies. Dr. Vikram Sarabhai, the founding father of the Indian space program, initiated India's space research activities during the 1960s.
- **ISRO Satellite Centre (ISAC)** - ISAC in Bangalore is the main center for developing and implementing satellite technology for scientific and technological missions.
- **Liquid Propulsion Systems Centre (LPSC), Thiruvananthapuram** - LPSC is the lead center in the development of liquid and cryogenic propulsion for launch vehicles and satellites.
- **Satish Dhawan Space Centre (SDSC-SHAR), Sriharikota** - The SDSC SHAR serves as the primary launch center for ISRO, offering a range of facilities such as solid propellant casting, static testing of solid motors, launch vehicle integration and launch operations, telemetry tracking and command network for range operation, and a mission control center.
- **Space Applications Centre (SAC)** - SAC at Ahmadabad is engaged in the development of pay loads for communication, meteorological and remote sensing satellites.
- **National Remote Sensing Centre (NRSC), Hyderabad** - NRSA Hyderabad is an autonomous institution under DOS responsible for satellite data acquisition, processing, dissemination, remote sensing, and decision support for disaster management.
- **Development and Educational Communication: Unit (DECU):** DECU in Ahmadabad handles space application planning, implementation and evaluation.

IMPORTANT MILESTONES IN THE INDIAN SPACE PROGRAM

1960-70

Dr. Vikram Sarabhai, known as the founding father of the Indian space program, was a highly regarded scientific visionary and national hero. He recognized the potential of satellites after the launch of Sputnik in 1957. India's first prime minister, Jawaharlal Nehru, shared his vision of scientific development as essential for the country's future and placed space research under the Department of Atomic Energy's jurisdiction in 1961. Under the leadership of Homi Bhabha, the director of DAE and father of India's atomic programme, the Indian National Committee for Space Research (INCOSPAR) was established in 1962, with Dr. Sarabhai as its Chairman.

The Indian Rohini programme continued to launch sounding rockets of greater size and complexity, and the space program was expanded, eventually becoming its own government department, separate from the Department of Atomic Energy. On August 15th, 1969, the Indian Space Research Organisation (ISRO) was created from the INCOSPAR program under the DAE. It continued under the Space Commission and finally the Department of Space, created in June of 1972.

1970-1980:

During the 1960s, Sarabhai participated in a NASA study that explored the possibility of using satellites for various applications, including direct television broadcasting. The study found that satellite transmission was the most economical method for broadcasting. Recognizing the potential benefits of satellites for India, Sarabhai and the ISRO worked on creating an independent launch vehicle capable of launching into orbit and providing valuable experience for future larger launch vehicles. The ISRO utilized India's advanced capability in building solid motors with the Rohini series and took inspiration from other nations' use of solid rockets. Thus, they developed the technology and infrastructure for the Satellite Launch Vehicle (SLV), a four-stage all-solid vehicle modeled after the American Scout rocket.

Aryabhata - India's first satellite

Meanwhile, India began developing satellite technology anticipating the remote sensing and communication needs of the future. India concentrated more on practical missions, directly beneficial to people instead of manned space programs or robotic space explorations. The Aryabhata satellite, launched in 1975 from Kapustin Yar using a Soviet Cosmos-3M launch vehicle, was India's first satellite.

SLV - India's first satellite launch vehicle

By 1979 the SLV was ready to be launched from a newly-established second launch site, the Satish Dhawan Space Centre (SDSC). The first launch in 1979 was a failure, attributed to a control failure in the second stage. By 1980 this problem had been worked out. The first indigenous satellite launched by India was called Rohini-1.

1980-1990:

After the successful launch of the SLV, ISRO expressed a strong interest in constructing a satellite launch vehicle capable of deploying valuable satellites into polar orbits. The development process for the Polar Satellite Launch Vehicle was initiated to fulfill this objective. The PSLV was designed to serve as India's primary system for launching payloads, combining both reliable solid-stages utilizing older technology and new liquid engines. Additionally, recognizing the importance of gaining experience with new technologies prior to full-scale production of the PSLV, ISRO also decided to develop a smaller rocket called the Augmented Satellite Launch Vehicle. The ASLV served as a testbed for testing various technologies including strap-on boosters and guidance systems that would be utilized by future missions launched by the PSLV.

Eventually, the ASLV underwent its inaugural flight test in 1987, which unfortunately ended in failure. Following minor adjustments, another launch was attempted in 1988, resulting in yet another unsuccessful outcome. However, this setback prompted a comprehensive investigation into the root causes of failure and provided invaluable lessons for future endeavors. It became evident that one of the major challenges encountered by the ASLV was maintaining control after removing stabilizing fins present on previous models such as the SLV. To address this issue effectively, additional measures were taken including enhancements to maneuvering thrusters

and upgrades to the flight control system. Furthermore, it is worth noting that developments related to strap-on motor technology made during ASLV's development phase also proved beneficial for subsequent projects.

1990-2000:

The ASLV's successful launch took place in 1992, but it could only carry small payloads. The PSLV's maiden flight was in 1993, but it failed. However, the PSLV's first successful launch happened in 1994 and it has become the primary launch vehicle for placing both communication and remote sensing satellites into orbit. The PSLV has also created the world's largest cluster of satellites, providing India's agriculture and industry with unique data. Over time, the rocket's payload capacity has significantly increased due to continual performance upgrades.

DEVELOPMENTS AFTER 2000 AND TIMELINE

2001

GSLV was successfully launched

2002

Kalpana-1 satellite was launched

2003

GSat-2 was launched

2004

Edusat was launched

2005

Launch of Cartosat-1 and Hamsat by PSLV

2006

GSLV was launched with Insat-4C

2007

Cartosat-2 was launched

2008

India's Chandrayaan-1 first moon mission was launched by PSLV. Almost a decade ago, India's first unmanned lunar probe was launched and was a landmark in India's space mission. Do you know that after this ISRO joined an elite list of just six space organisations to send an Orbiter to the moon? A Tricolour was hosted on the moon but ISRO lost contact with Chandrayaan-1 soon after.

2009

Radar Imaging Satellite (Risat-2) was launched

2010

Launch of Cartosat-2B, STUDSAT and three small foreign satellites by PSLV

2011

Launch of Resourcesat-2 and two small satellites by PSLV

2012

Risat-1 was launched by PSLV

2013

PSLV-C22 was successfully launched with India's first indigenous Regional Navigation Satellite IRNSS-1A on 1st July, 2013.

PSLV-C25/Mars Orbiter Mission was launched in 5 November, 2013

2014

- GSLV-D5 was successfully launched on 5 January, 2014.
- India's first interplanetary mission to the planet Mars known as Mars Orbiter mission (MOM) or Mangalyaan was launched. On 24 September, 2014, MOM entered Mars orbit. India became the first country in the world to insert a spacecraft into the Martian orbit in its very first attempt.
- On 18 December, 2014, GSLV Mk-III, the first experimental flight of ISRO's heaviest and upgraded rocket vehicle was launched from Sriharikota.

2015

- India's 4th navigation satellite was launched.
- 100 days of Mangalyaan.
- 5 British satellites are launched by ISRO.
- On 28 September, 2015, India's first dedicated multi-wavelength space observatory Astrosat was successfully launched onboard a PSLV-C30 rocket.
- On 11 November, 2015, latest communication satellite of India GSAT-15 was successfully launched by Ariane-5 rocket from the spaceport of Kourou in French Guiana.
- On 16 December, 2015, PSLV-C29, in its 32 flights, launched six satellites of Singapore. Of these six satellites, TeLEOS-1 is the primary satellite whereas the other five are co-passenger satellites.

2016

- On 20 January, 2016 PSLV-C31 in its 33rd flight launches IRNSS-1E, the fifth satellite of the Indian Regional Navigational Satellite System (IRNSS).
- On 10 March, 2016, PSLV-C32 in its 34th flight, launches IRNSS-1F, the sixth satellite of the Indian regional navigational Satellite System (IRNSS). This is the thirty third consecutively successful mission of PSLV.
- On 28 April, 2016, PSLV-C33 in its 35th flight, launches IRNSS-1G, the seventh satellite of the Indian Regional Navigation Satellite System (IRNSS) to a Sub-Geosynchronous Transfer Orbit (Sub-GTO).
- On 23 May, 2016, RLV-TD was successfully flight tested.

- On 22 June, 2016, PSLV-C34, in its 36 flight launches the 727.5 kg Cartosat-2 Series Satellite for earth observation and 19 co-passenger satellites together weighing about 560 kg at lift-off into a 505 km polar Sun Synchronous Orbit (SSO).
- On 28 August, 2016, the first experimental mission of ISRO's Scramjet Engine towards the realization of an Air Breathing Propulsion System was successfully conducted.
- On 8 September, 2016, GSLV-F05 is the tenth flight of India's Geosynchronous Satellite Launch Vehicle (GSLV), launching INSAT-3DR, an advanced weather satellite, weighing 2211 kg into a Geostationary Transfer Orbit (GTO).
- On 26 September, 2016, PSLV-C35, in its 37th flight, launches SCATSAT-1 for weather related studies and 7 co-passenger satellites into polar Sun Synchronous Orbit (SSO).
- On 6 October, 2016, India's latest communication satellite GSAT-18 was inducted into the INSAT/GSAT system.

2017

- On 15 February, 2017, ISRO successfully launched 104 satellites using a single rocket from Sriharikota Space Centre.
- On 5 May, 2017, GSLV successfully launches South Asia Satellite.
- On 5 June, 2017, first developmental flight of India's GSLV Mk III successfully launches GSAT-19 Satellites.
- On 23 June, 2017, PSLV-C38 successfully launches 31 Satellites in a single flight.
- On 29 June, 2017, India's GSAT-17 Communication Satellite launches successfully.
- On 31 August, 2017, PSLV-C39 flight carrying IRNSS-1H Navigation Satellite unsuccessful.

2018

- On 12 January, 2018 PSLV successfully launches 31 Satellites in a single flight.
- On 23 March, 2018 ISRO-BHEL tie up for the production of Space Grade Lithium-Ion Cells.
- On 29 March, 2018 GSLV successfully launches GSAT-6A Satellite.
- On 12 April, 2018 PSLV-C41 successfully launches IRNSS-11 Navigation Satellite.
- On 25 April, 2018 GSAT-11 launch rescheduled.
- 22 June, 2018, discovery of a Sub-Saturn like Planet around a Sun-like star.
- On 16 September, 2018 PSLV-C42 launches 2 foreign satellites.
- On 14 November, 2018 GSLV MkIII-D2 successfully launches GSAT-29.
- On 29 November, 2018 PSLV-C43 successfully launches HysIS and 30 customer satellites.
- On 5 December, 2018, GSAT-11 India's heaviest communication satellite launched successfully from French Guiana.
- On 19 December, 2018, GSLV-F11 successfully launches GSAT-7A

2019

- On 25 January, 2019, PSLV-C44 successfully launched Microsat-R and Kalamsat-V2.
- On 6 February, 2019 GSAT-31 India's Communication Satellite launched successfully from French Guiana.
- On 1 April, 2019 PSLV-C45 successfully launches EMISAT and 28 customer satellites.

- On 22 May, 2019 PSLV-C46 successfully launches RISAT-2B
- On 15 July, 2019 Chandrayaan-2 Moon Mission will be launched.

2020

- On 17 January, 2020, Ariane-5 VA-251 successfully launched GSAT-30
- On 07 November, 2020, PSLV successfully launches EOS-01 and nine customer satellite from Sriharikota
- On 17 December, 2020, PSLV-C50 successfully launches CMS-01 from Satish Dhawan Space Centre SHAR, Sriharikota

2021

- On 28 February, 2021, PSLV-C51, the first dedicated launch for NSIL, successfully launches Amazonia-1 and 18 Co-passenger satellites from Sriharikota
- On 12 August, 2021, GSLV-F10 successfully launched EOS-03 is a state-of-the-art agile Earth observation satellite

2022

- On 14 February, 2022, PSLV-C52 successfully launched Earth Observation Satellite EOS-04
- On 22 June, 2022, GSAT-24 was successfully launched
- On June 30, 2022, ISRO undertakes PSLV-C53/DS-EO mission
- SSLV-D1 was expected to launch EOS-02 and AzaadiSAT satellites but it failed
- On October, 2022, LVM3 M2 successfully placed 36 satellites of OneWeb to their intended orbits
- On 26 November, 2022, PSLV-C54 has successfully launched EOS-06 satellite along with Eight Nano-satellites into two different SSPOs

2023

- On February 10, 2023, SSLV-D2 successfully Injected EOS-07 satellite and two passenger satellites Janus-1 & AzaadiSAT-2 into 450 km circular orbit.
- On 26 March, 2023, LVM3, the vehicle placed 36 satellites belonging to the OneWeb Group Company in their intended 450 km circular orbit.
- On 2 April, 2023, ISRO successfully conducts the Reusable Launch Vehicle Autonomous Landing Mission (RLV LEX).
- On 19 April, 2023, PSLV-C55 successfully launched TeLEOS-2 as primary satellite and Lumelite-4 as a co-passenger satellite
- On 22 May, 2023, GSLV-F12 mission deployed NVS-01 navigation satellite
- On 14 July, 2023, GSLV-III rocket launched the Chandrayaan-3 mission
- On 30 July, 2023, PSLV rocket launched the DS-SAR mission
- On 2 September, 2023, PSLV-XL launched Aditya L1 Mission

UPCOMING MISSIONS:

Shukrayaan Mission: The Venus Orbiter Mission, unofficially known as Shukrayaan, is a planned Indian Space Research Organisation mission to study the surface and atmosphere of Venus

Own Space Station: The ISRO Space Station is a planned space station to be constructed by India and operated by Indian Space Research Organisation. The space station would weigh 20 tonnes and maintain an orbit of approximately 400 kilometres above the Earth, where astronauts could stay for 15–20 days.

XpoSatst (X-ray Polarimeter Satellite) is India's first dedicated polarimetry mission to study various dynamics of bright astronomical X-ray sources in extreme conditions. Space observatory, XpoSat, designed to study cosmic x-rays.

NASA-ISRO SAR (NISAR) is a Low Earth Orbit (LEO) observatory being jointly developed by NASA and ISRO

SPADEX or Space Docking Experiment is a twin spacecraft mission being developed by Indian Space Research Organisation to mature technologies related to orbital rendezvous, docking, formation flying, with scope of applications in human spaceflight, in-space satellite servicing and other proximity operations.

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