

Indian Space Research Organization (ISRO)- Science Highlights

SPACE SCIENCE WEEK 2023

Spring 2023 Meeting of the Discipline Committees of the Space Studies Board

Washington DC| March 28-30, 2023



KRUNAL JOSHI

***Counsellor, Space/ISRO Representative in USA
Embassy of India, Washington DC, USA***

India's Accomplishments in Space

- PSLV
- GSLV
- LVM-3
- SSLV

**89 LV
MISSIONS**



L V Mk III

>50 successful
flights (PSLV)



GSLV



SSLV

>400 Satellites of 34 countries

Dr. Vikram Sarabhai



“..we must be second
to none in the
application of
advanced
technologies to the
real problems of man
and society.”

123 Satellites

- Remote Sensing
- Communication
- Navigation
- Space Science



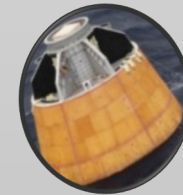
**13
Student
satellites**

5 Experimental missions

**Space Capsule
Recovery
Experiment**



**Crew Module
Atmospheric
Re-entry Experiment**



**Reusable Launch
Vehicle
Technology
Demonstrator**



**Scramjet Engine
Technology
Demonstrator**



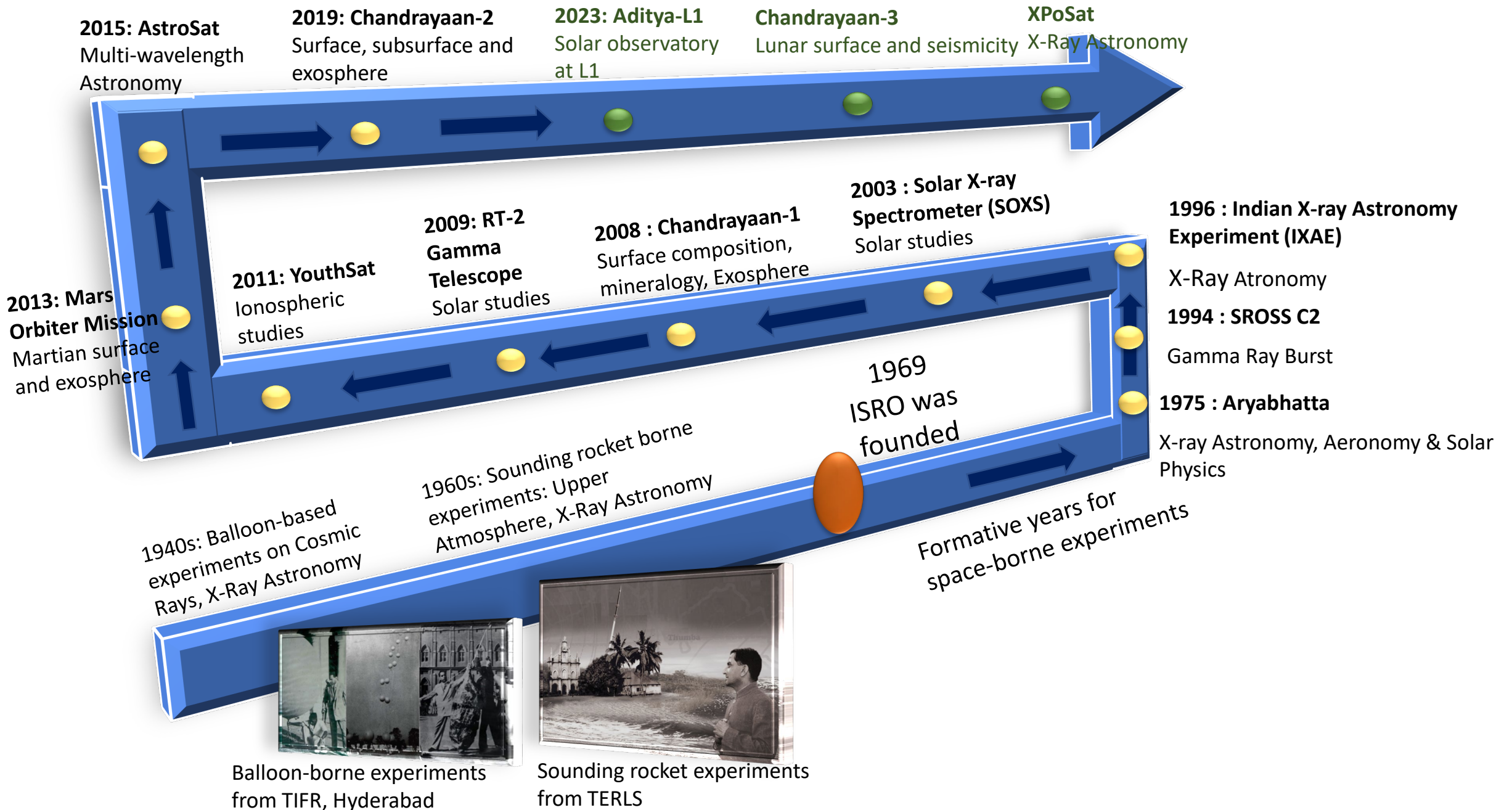
**Crew Escape System
at Launchpad**



**>250
Applications**



The Legacy and Roadmap of the Space Science Programme



Space Science Exploration of ISRO

Vision: Scientific Exploration of the Solar System and beyond: Understanding how the Universe works; and use space for fundamental science experiments

Major Verticals of ISRO's Space Science Programme

Astronomy & Astrophysics

Planetary Exploration

Heliophysics & Space Weather Studies

Upper Atmospheric Studies-Aeronomy

Observations

Space Missions

Observations from space

Ground Based Studies

Atmospheric radars, ionosondes, GPS receivers, etc.

Modelling

Physics-based Modelling

Based on the understanding of the physical processes

Data-driven approach

AI/ML Modelling

The ISRO / DOS Centres that Contribute to Space Sciences

Space Applications Centre (SAC), Ahmedabad

- Planetary Geology
- **Develops optical, infra-red and hyper-spectral payloads for planetary surface studies**

Physical Research Laboratory (PRL), Ahmedabad

- Space & planetary science, atmospheric science, astronomy & astrophysics
- **Develops payloads for solar science, planetary surface and atmospheric science**

Vikram Sarabhai Space Centre (VSSC) & Space Physics Laboratory (SPL), Thiruvananthapuram

- Planetary, Space and Atmospheric Sciences
- **Develops of atmospheric and ionospheric payloads for planetary science missions**



Deliverables from centres / laboratories

- Scientific payloads
- Theoretical models that describe the processes under study; algorithms to delineate scientific information from payloads

National Atmospheric Research Laboratory (NARL), Gadanki

- **Atmospheric science**

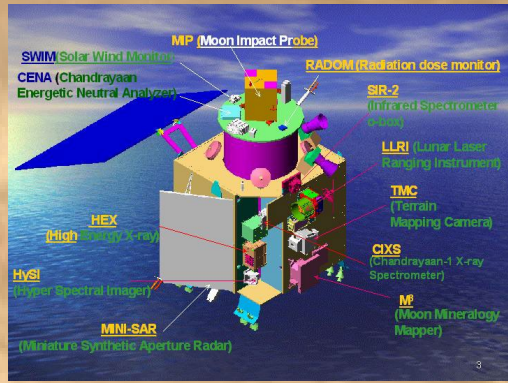
Indian Space Science Data Centre (ISSDC)

- Space Science Mission Data Archival, and Dissemination interface

U R Rao Satellite Centre (URSC), Bangalore & Laboratory for Electro Optical System (LEOS)

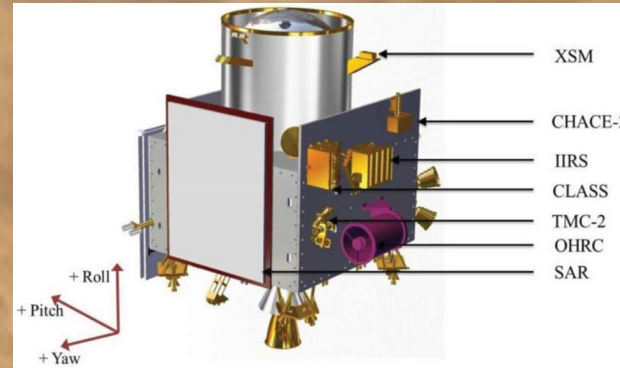
- Astronomy, Solar physics, planetary science
- **Develops astronomy payloads, planetary X-Ray Fluorescence payloads**
- **Optical and Seismology payloads**

Major Science Highlights from ISRO's Science Missions



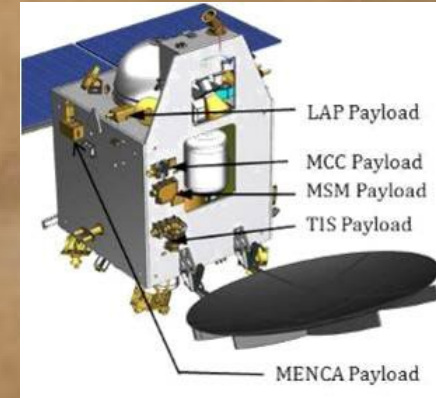
Chandrayaan-1

- Hydration signatures on lunar surface and exosphere
- Evidences of recent lunar volcanism
- Interactions of solar wind with the lunar surface
- Discovery of ion populations in the lunar wake region



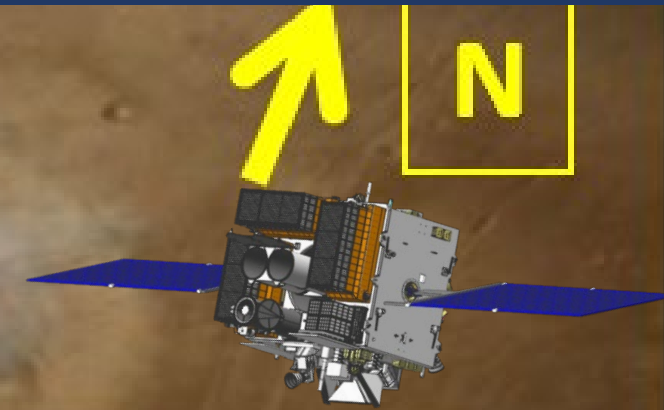
Chandrayaan-2

- Hydration mapping on lunar surface at extended IR wavelength
- First-ever global mapping of exospheric Ar-40, and global surface distribution of Na
- Detection of trace elements like Cr and Mn
- Highest resolution (~ 0.25 m) camera for surface studies
- Subsurface studies with SAR



Mars Orbiter Mission

- Exospheric neutral composition
- Solar forcing on evening side exosphere
- Coordinated observations: MAVEN/NASA
- Surface studies; polar caps; imaging of Phobos and Deimos



AstroSat

- Discovery of Ly-alpha photons from a galaxy 9.3 billion years away
- Solving the puzzle of a source bright in both UV and IR $\rightarrow$ discovery of a hidden white dwarf
- Discovery of extended emission (~ 3 times more) in butterfly nebula
- FUV observation revealing hot stars in Stephen's quintet, complementing JWST observations

Upcoming Mission to Moon: Chandrayaan-3

Science Objective

To study the thermo-physical properties, seismicity & elemental composition in the vicinity of the landing site.

- ❑ Follow-on to Chandrayaan-2 to demonstrate landing and roving on the lunar surface
- ❑ Lander, Rover with a Propulsion module.
- ❑ Landing at Southern high latitudes on the Moon.



LANDER



Thermal Probe



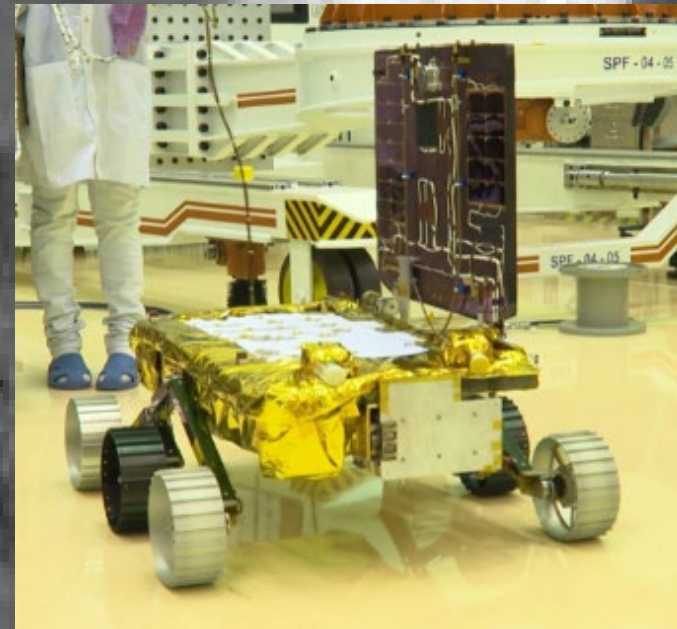
Langmuir Probe



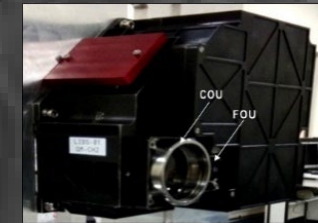
Seismometer



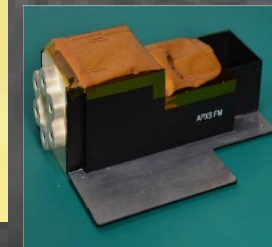
**Lunar Retroreflector
Array (NASA)**



ROVER



**Alpha Particle X-ray
Spectrometer**



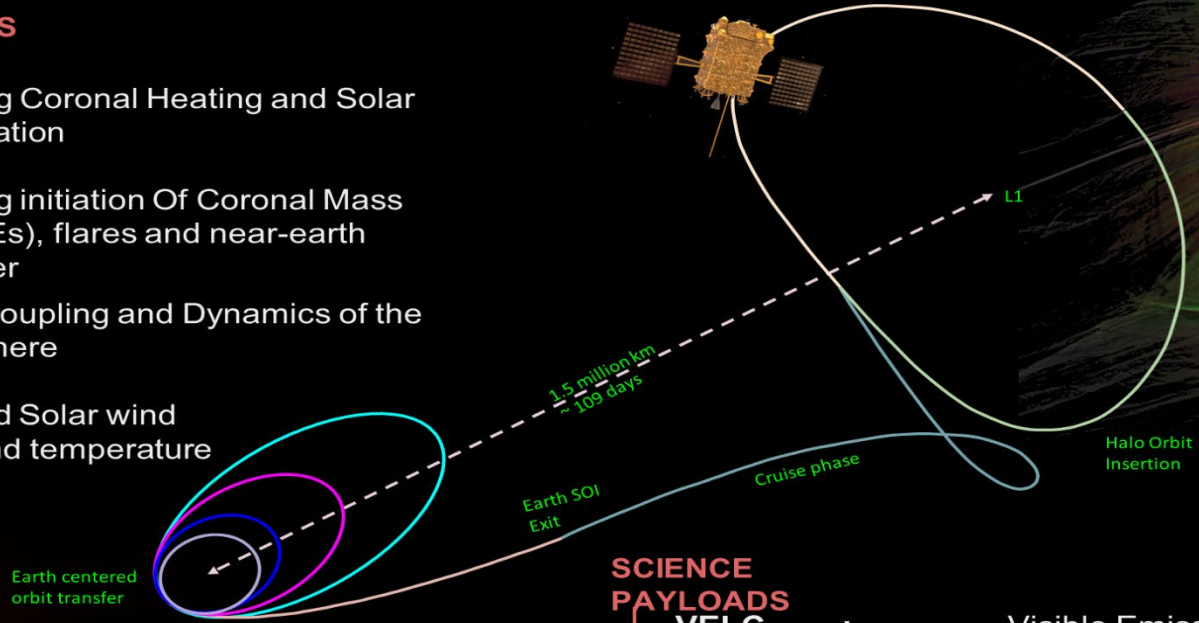
**Laser Induced
Breakdown
Spectroscope**

Upcoming Solar Science Mission: Aditya-L1

First Indian observatory class mission for solar & heliospheric studies.
Mission planned life – 5-years.
Continuous observation of the sun from Earth-Sun Lagrange point L1

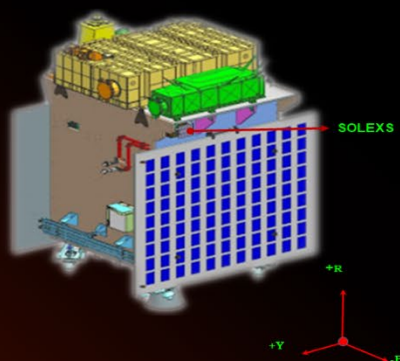
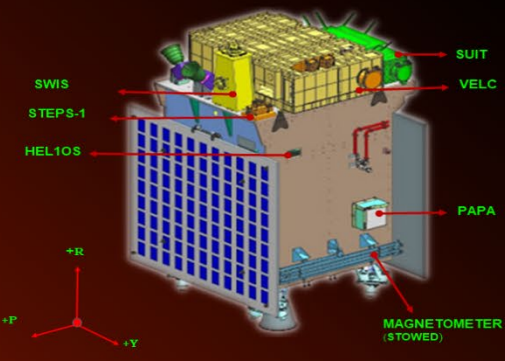
SCIENCE OBJECTIVES

- ❖ Understanding Coronal Heating and Solar Wind Acceleration
- ❖ Understanding initiation Of Coronal Mass Ejection (CMEs), flares and near-earth Space weather
- ❖ Understand Coupling and Dynamics of the solar Atmosphere
- ❖ To understand Solar wind distribution and temperature anisotropy.

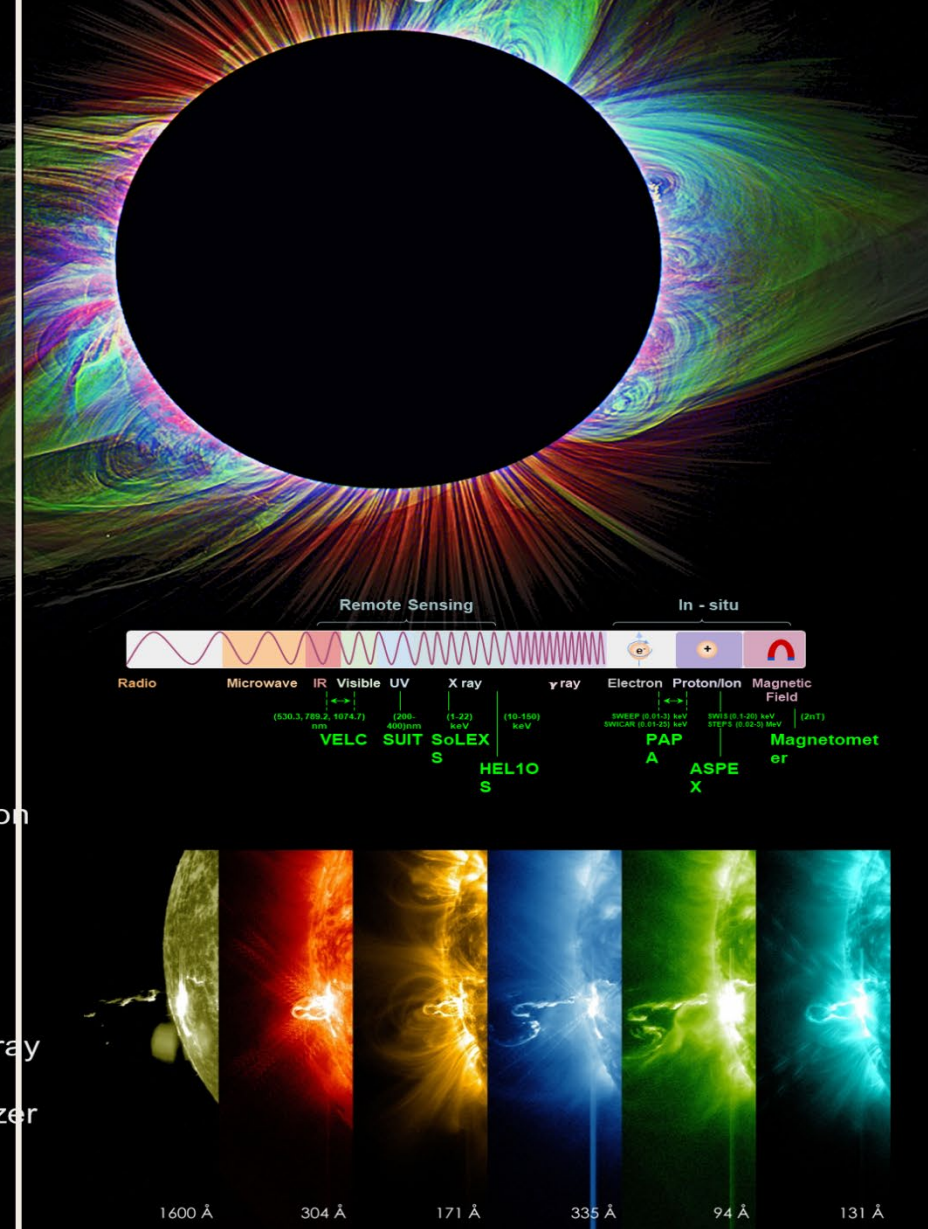


SCIENCE PAYLOADS

VELC : Visible Emission Line
HEL10S: High Energy L1 Orbiting X-ray Spectrometer
SUIT : Solar Ultraviolet Imaging Telescope
SoLEXS: Solar low energy X-ray Spectrometer
PAPA : Plasma Analyzer Package
ASPEX: Aditya Solar wind Particle

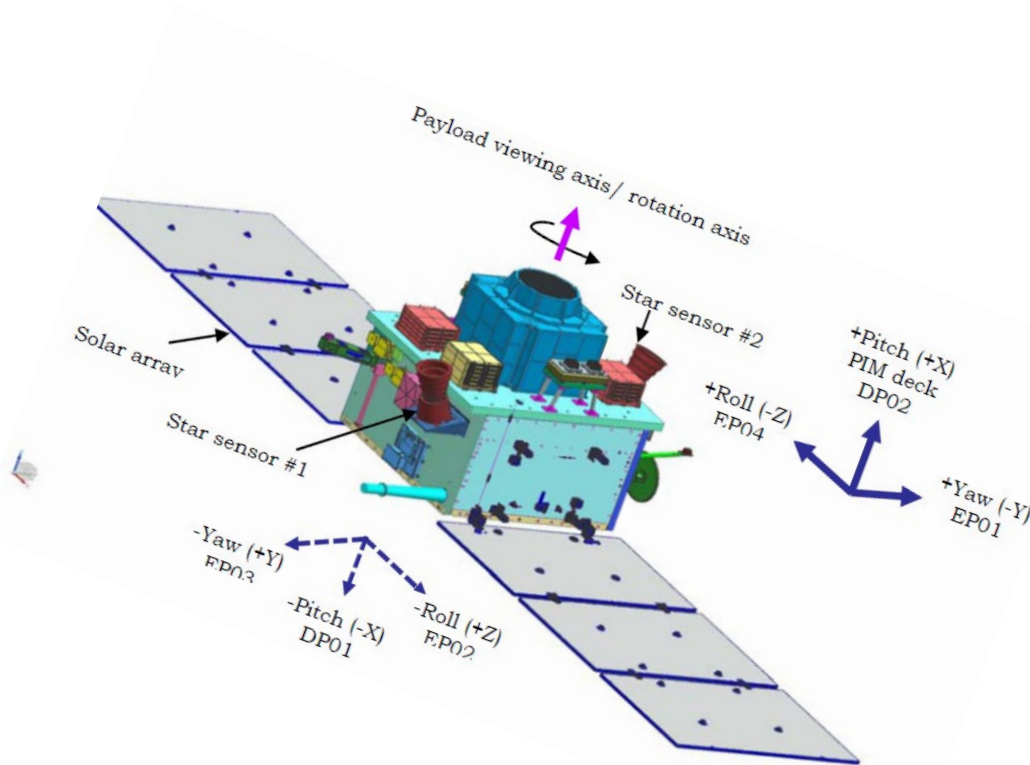


A multiwavelength view of the Corona



Upcoming Astronomy Mission: XPoSat (X-Ray Polarimeter Satellite)

XPoSat deployed view



- First dedicated satellite for Polarization measurement in medium energy X-rays
- XPoSat will extend the range of X-ray polarization measurement (8-30 keV) beyond IXPE (2-8 keV) range.

Major science goals:

- Pulse phase polarimetry of bright X-ray Pulsars
- Understanding emission mechanism from bright Black hole sources.

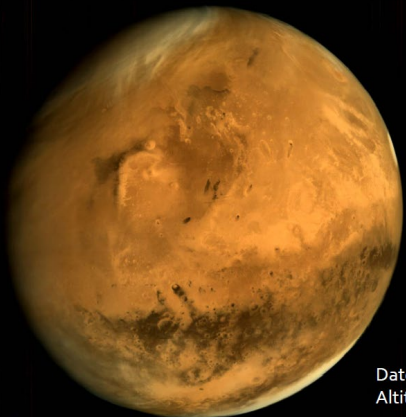
Two payloads:

- **POLIX** : **P**olarimeter **I**nstrument in **X**-rays (8-30 keV)
- **XSPECT** : **X**-ray **S**pectrometer (1-15 keV)

Missions in Preparatory / Concept Phase

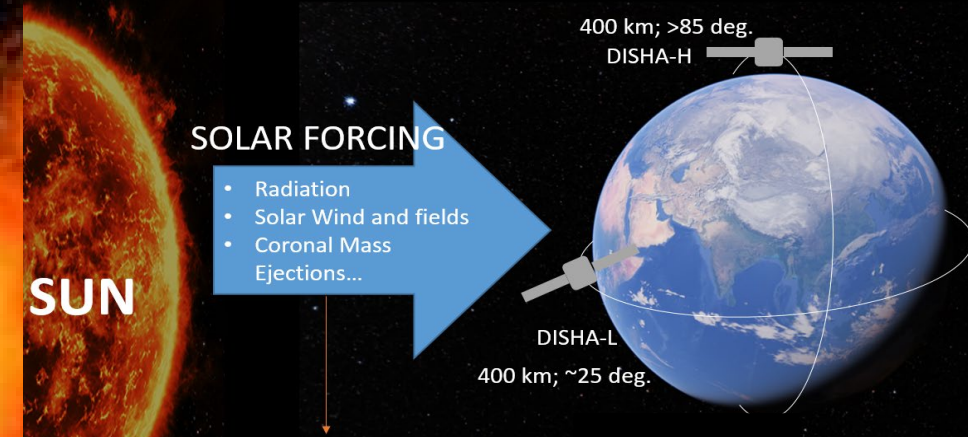


Mission to Venus



Date – 1st October, 2014
Altitude – 66, 500km

Mars Lander Mission: Concept Stage



Dual Aeronomy Mission-DISHA

Illustrations of International Collaboration



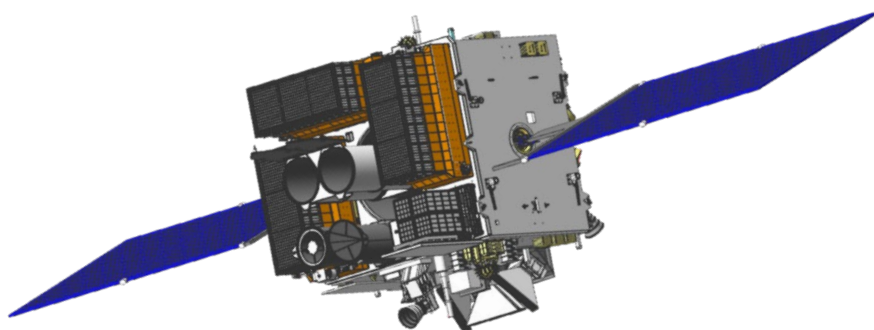
Chandrayaan-1 : A True Representation of Mankind to Moon



JPL

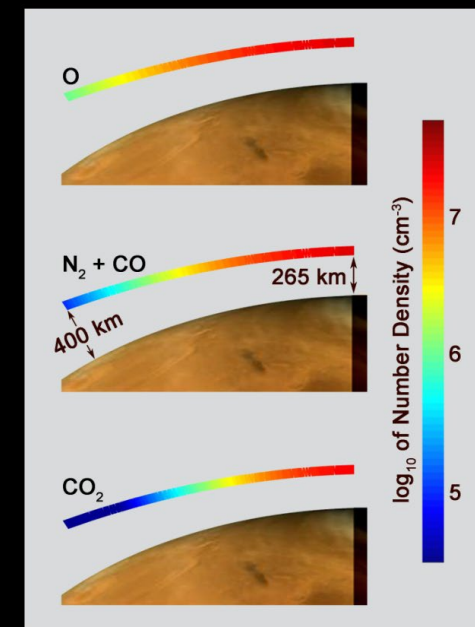


Payload Contribution in Ch-1 (USA, UK, Germany, Sweden and Bulgaria) and Science collaboration



AstroSat India's first dedicated Space Astronomy Observatory
2000+ users from 54 countries
UVIT and SXT collaborated with CSA and University of Leicester respectively

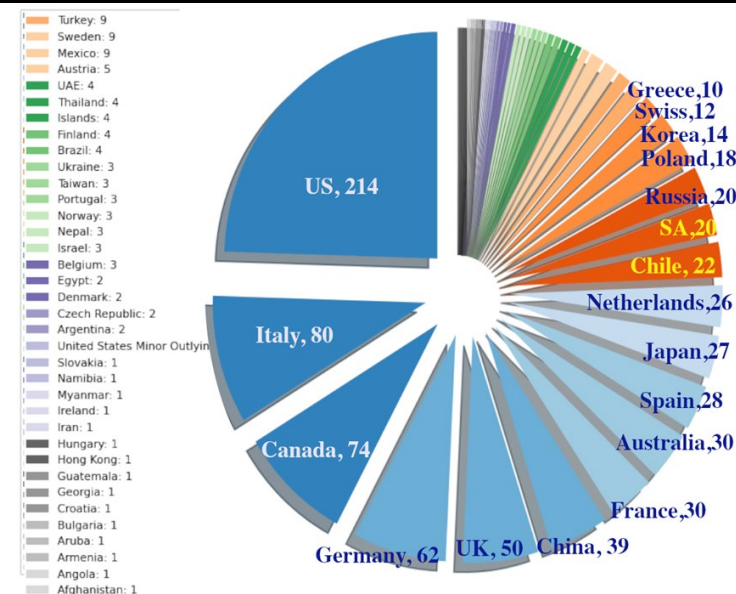
Example of Joint Operation of Missions



MAVEN (NASA) observed the Martian exosphere during local noon

MOM Orbit

MOM observed the Martian exosphere during local evening



Repository of the Space Science Data



भारतीय अंतरिक्ष विज्ञान आँकड़ा केंद्र (आई.एस.एस.डी.सी)
इसरो दूरमिति, अनुवर्तन तथा आदेश संचारजाल (इस्ट्रैक)
अंतरिक्ष विभाग, भारत सरकार

Indian Space Science Data Center (ISSDC)
ISRO Telemetry, Tracking and Command Network (ISTRAC)
Department of Space, Government of India

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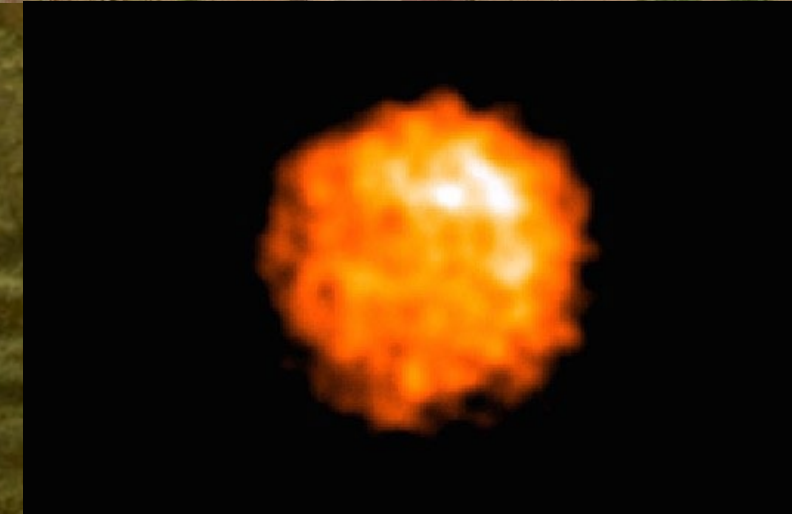


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<https://www.issdc.gov.in/>



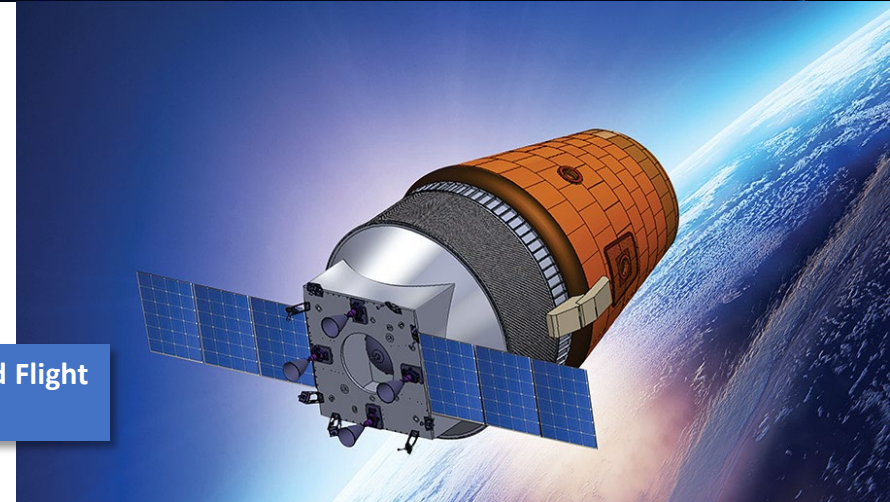
X Ray image of Supernova: Astrosat

Three linked Craters of Mars

Exploring New Territories

Gaganyaan

Indian Human Spaceflight Programme



NASA-ISRO synthetic Aperture Radar-NISAR



India-US Space Cooperation:
Combating climate change together

Ecosystem Structure – Forest / Agriculture
Biomass, Canopy, Climate Change Response,
Crop Monitoring

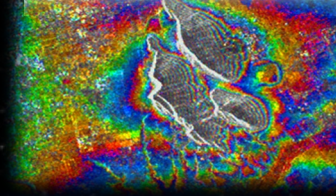
Land Surface Deformation, Volcanism

Cryosphere- Ice/Glacier Dynamics, Stock

Coastal / Oceanography

Hazard Response – Flood, Landslide, Oil Spills,
Earthquake

EQ Deformation



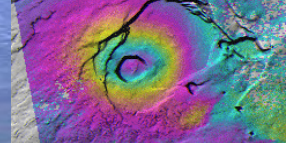
Coastal Erosion



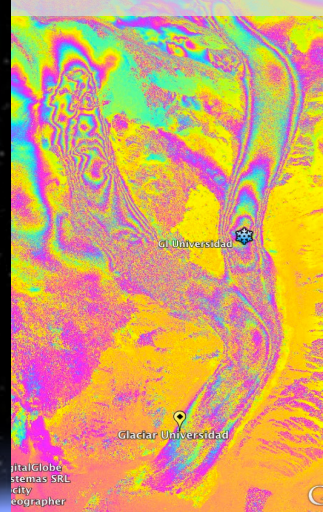
Crop Monitoring



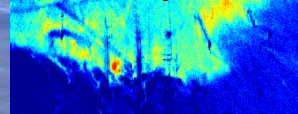
Volcano



Glacier Velocities



Oil Spills

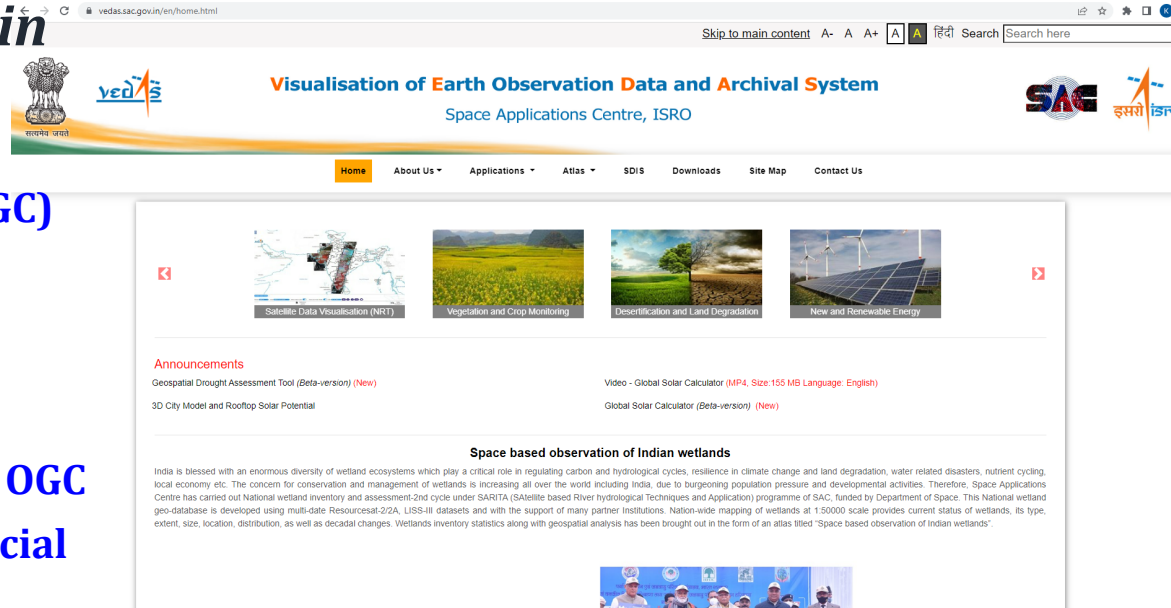


First radar of its kind in space to systematically map the Earth, using two different radar frequencies (L-band and S-band) to measure changes in our planet's surface with high accuracy

ISRO's Geo Platforms: Enabling the community



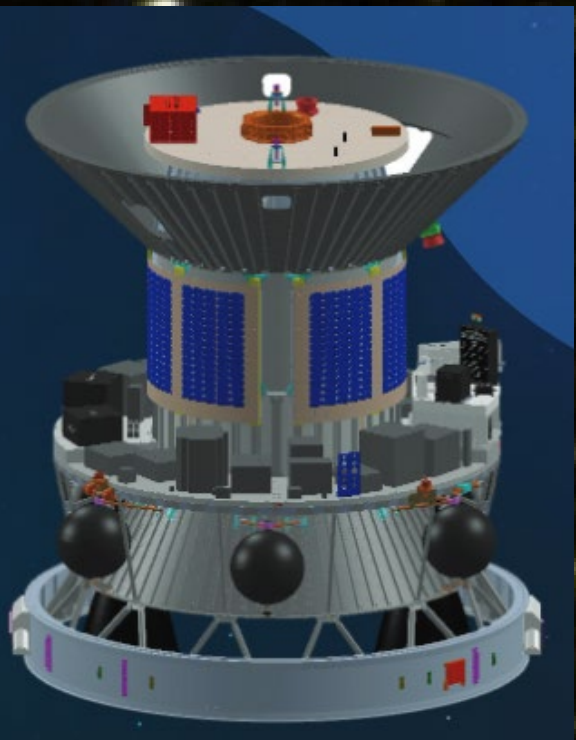
<https://bhuvan.nrsc.gov.in>



<https://vedas.sac.gov.in>

- Satellite based geo-spatial data Archival, Visualisation and Analysis
- Use of open-source and in-house developed technologies
- Platform for Big Data Analysis and applications of AI in various fields
- Platform for Research & training to Academia

- Open Geospatial Consortium(OGC) compliance in 2010
- Versatile viewing platform with capabilities 2D/2.5D/3D.
- Interactive thematic services as OGC Services - Disaster Services, Special Applications



Space is a common heritage of the humankind.

Indian Space Programme: Inclusive → Global Collaboration

Working
Groups

Launch / Observation
platforms

Joint missions

Joint
payloads

Joint
operations

Opportunities for innovative endeavors → PS-4 platform

Openness of the science data

Together we grow

Thanks

Email: cisro.washington@mea.gov.in