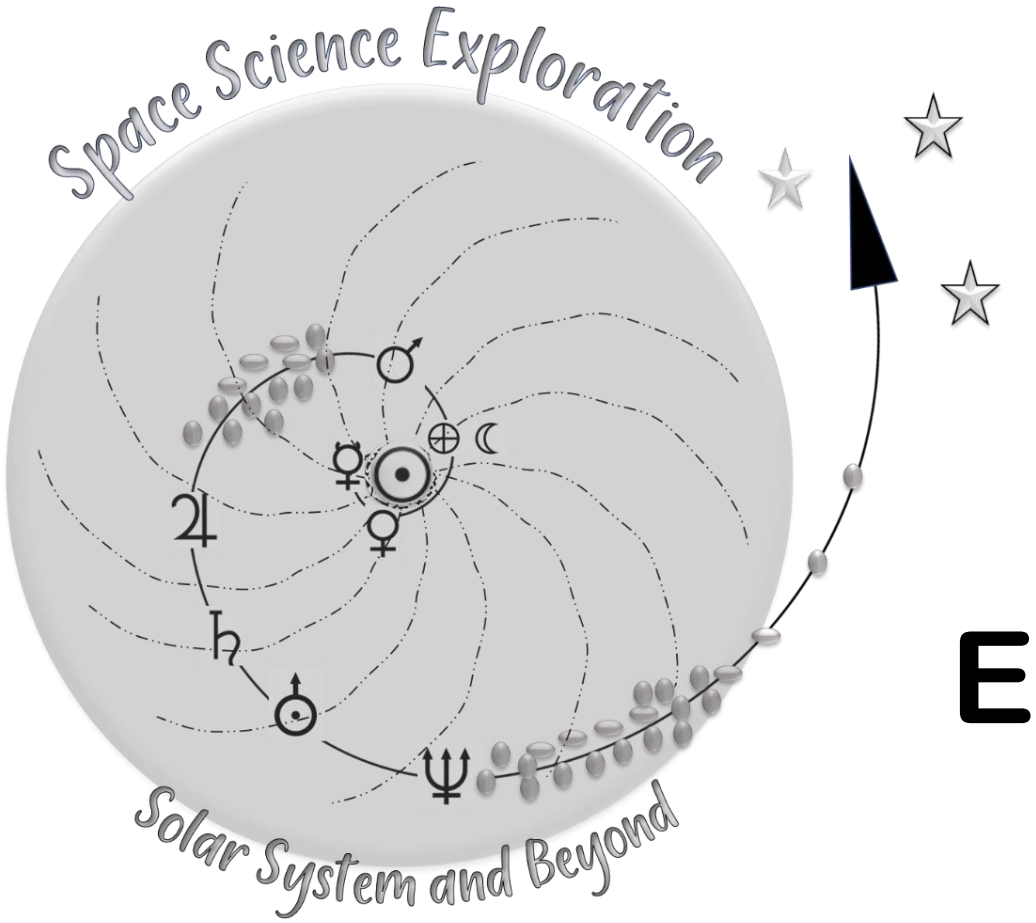

ISRO's Space Science Exploration Programme

NRSC User Meet: 2022

Dr. Tirtha Pratim Das
Director,
Science Programme Office (SPO), ISRO Headquarters, Bangalore
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From Sounding Rockets to Satellites

Started from Thumba Equatorial Rocket Launching Station (TERLS), Kerala, India in 1960s for upper atmosphere and ionospheric studies

Evolved to Planetary exploration and space observatory capabilities

- Chandrayaan-1,2 missions
- Mars Orbiter Mission
- Astrosat Mission
- Several missions in approval phase

Major Themes of the Space Exploration Programme

1. Planetary Exploration (Current focus on Moon, Mars)
2. Heliophysics & Space Weather Studies, including Aeronomy
3. Astronomy & Astrophysics, including Exoplanets

Observations

Space Missions — Observations from space

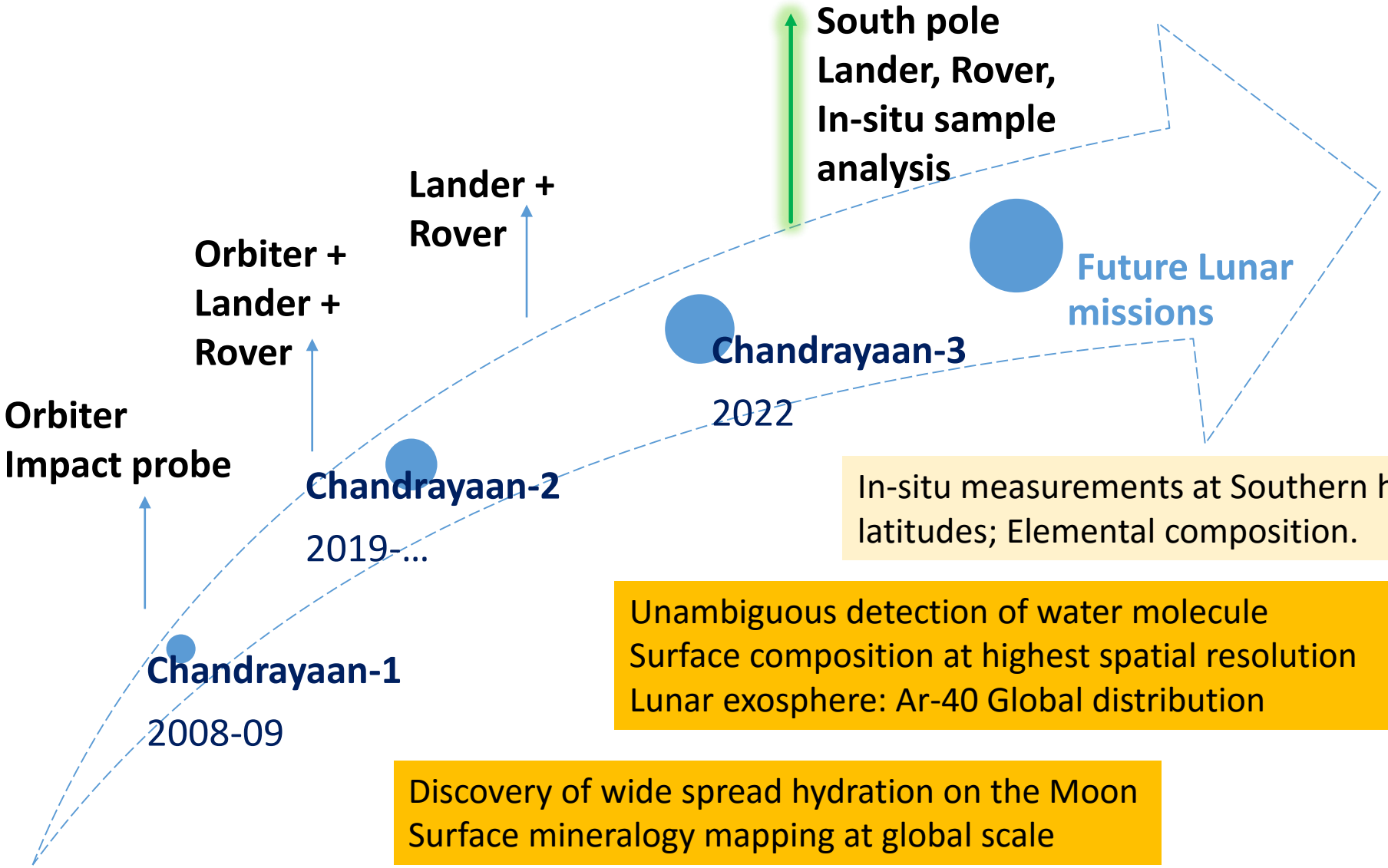
Ground Based Studies — Atmospheric radars, ionosondes, GPS receivers, etc.

Modelling

Physics-based Modelling — Based on the understanding of the physical processes

AI/ML Modelling — Data-driven approach

Exploration of the Moon



Immediate Questions

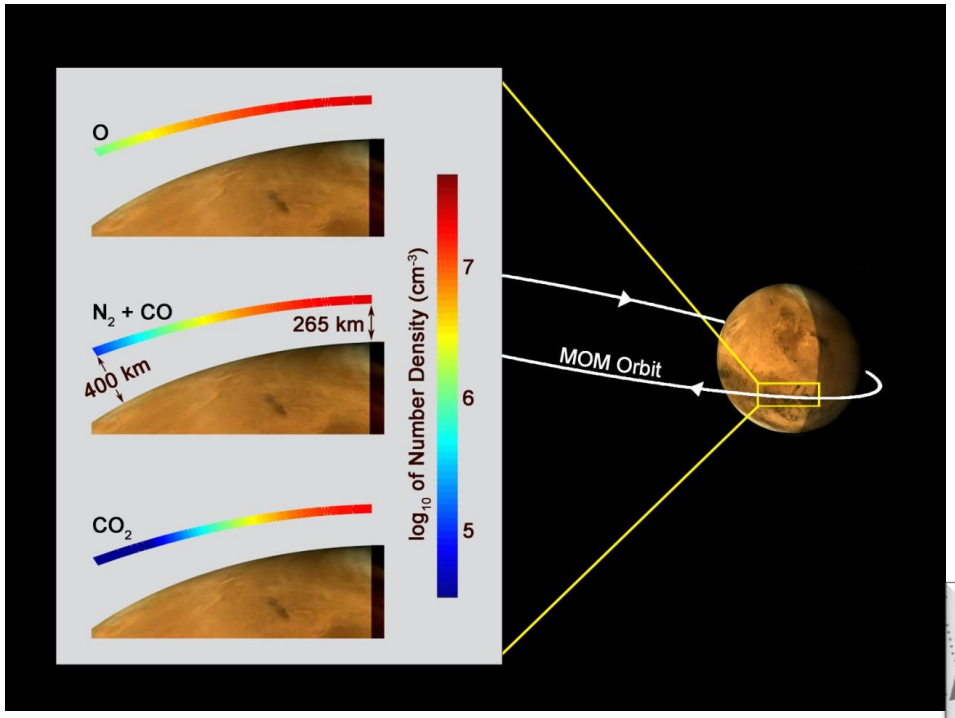
- In-situ study of surface/ sub-surface Water/water-ice and other volatiles at Poles.
- Direct study of PSR and PIR

In-situ measurements at Southern high latitudes; Elemental composition.

Unambiguous detection of water molecule
Surface composition at highest spatial resolution
Lunar exosphere: Ar-40 Global distribution

Discovery of wide spread hydration on the Moon
Surface mineralogy mapping at global scale

Exploration of Mars

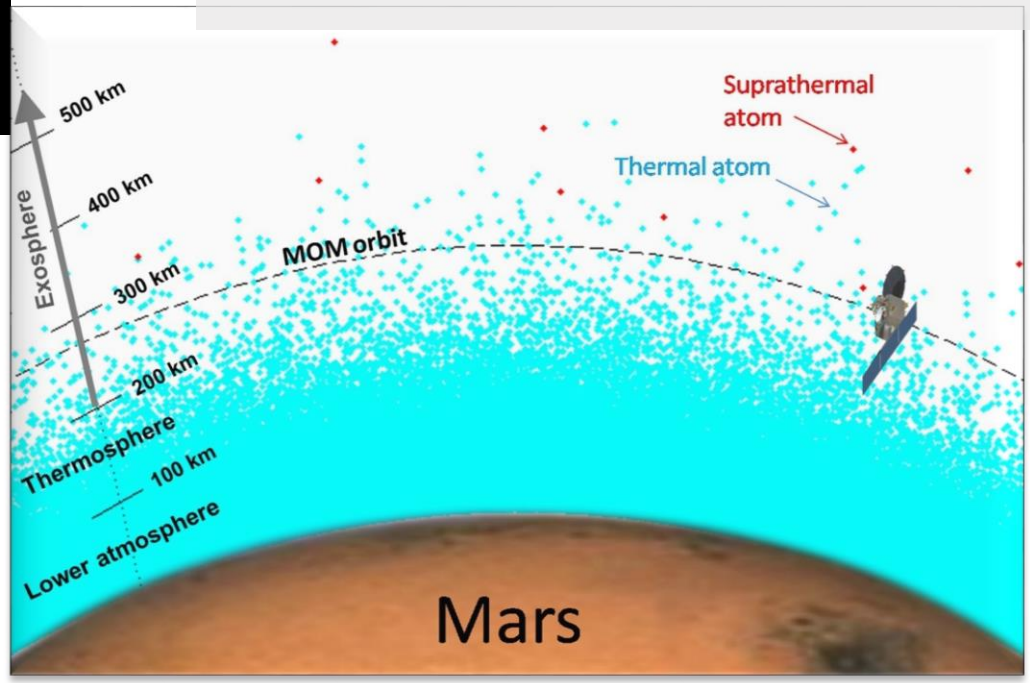


The first *in situ* Composition measurements of the Martian dusk sector.

Major exospheric species : amu 44, amu 28, and amu 16.
Altitutde region : 260 –375 km.
(Exosphere of Mars)

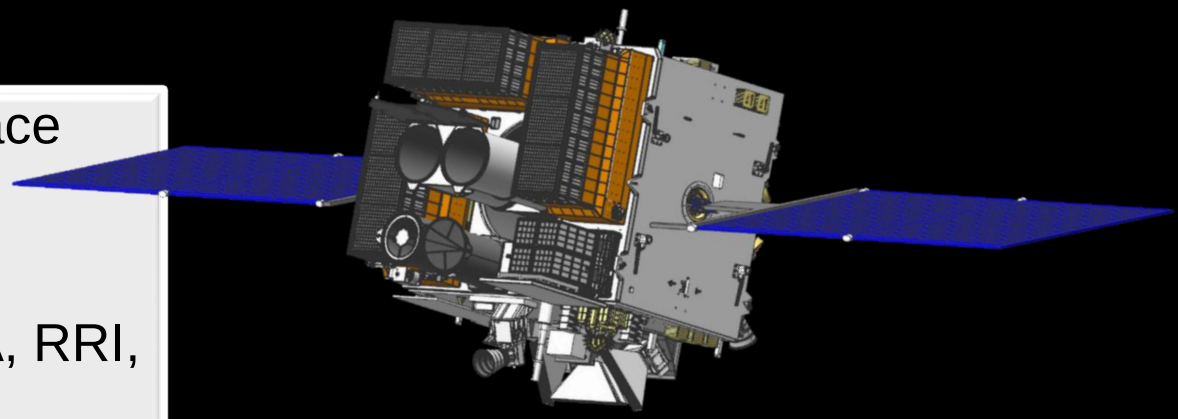
Discovery of suprathermal Argon-40 in Mars exosphere….

- Important clue to understand the energy budget of exosphere of Mars
- Clue to understand the escape of atmosphere from Mars



Exploration in Astronomy: AstroSat (2015-)

- Multi-wavelength (UV, Vis, soft and hard X-ray) space observatory
- First dedicated Astronomy satellite from ISRO
- Involvement of national institutes (TIFR, IIA, IUCAA, RRI, NCRA) in space instrumentation and science.
- Launched from Sriharikota on 28th sept 2015
- Operating as proposal based observatory



- 206 Publications
- 1400+ users from 49 countries
- 30 Data utilisation projects
- 11th AO cycle is in progress.

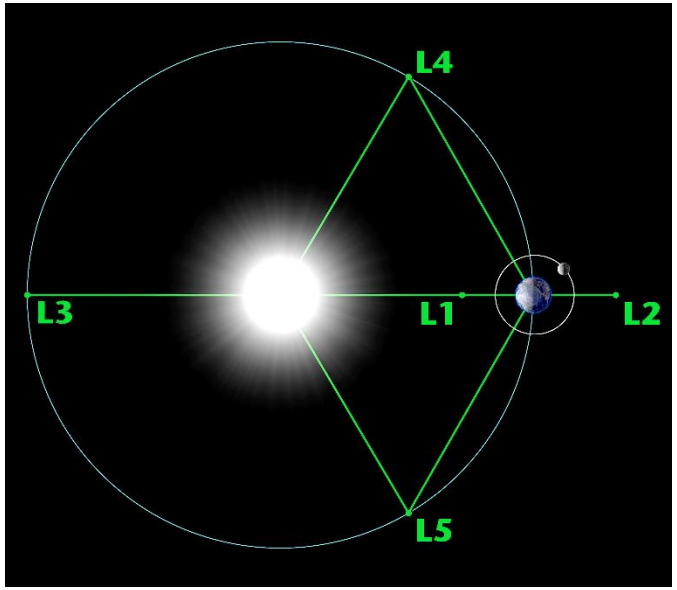
Scientific Payloads

- Ultra Violet Imaging Telescope (UVIT)
- Soft X-ray Telescope (SXT)
- Large Area X-ray Proportional Counters (LAXPCs)
- Cadmium Zinc Telluride Imager (CZTI)
- Scanning Sky Monitor (SSM)

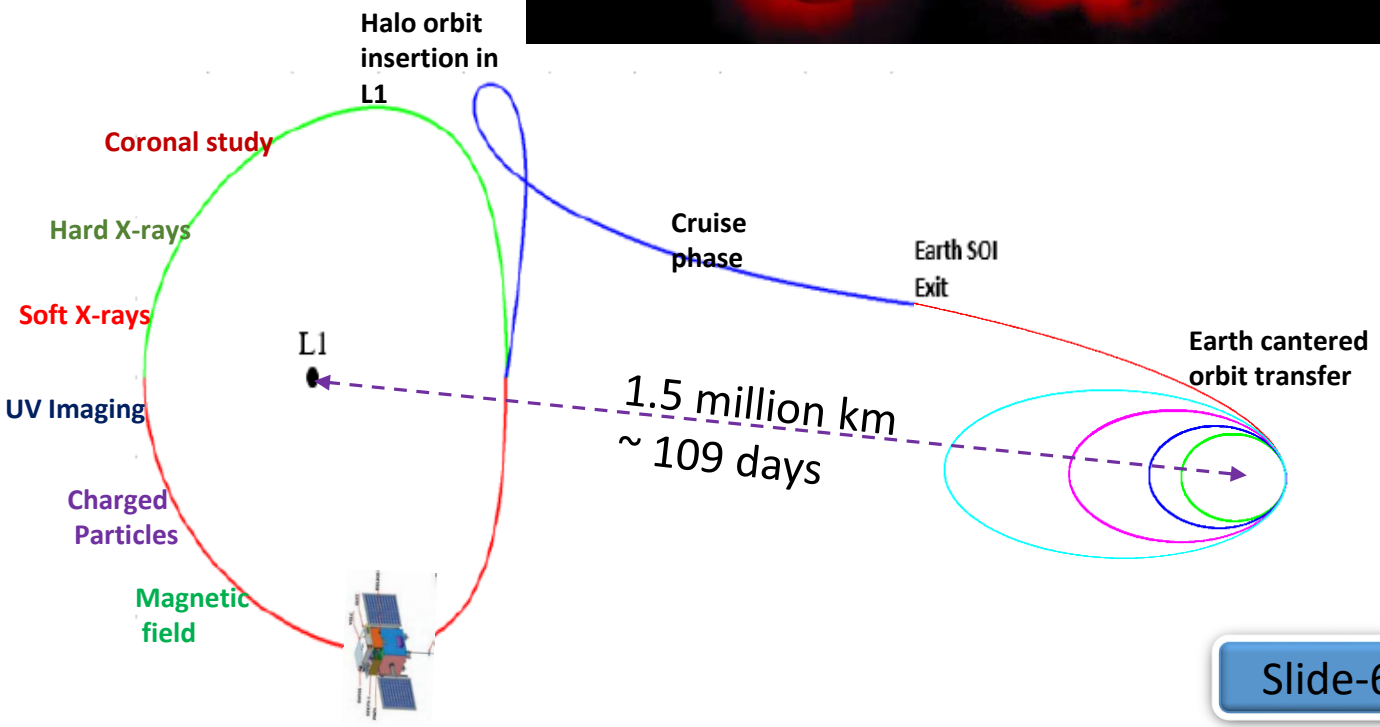
Launch: 28 Sep 2015 by PSLV-C30; Completed 6+ years in orbit

Aditya L1: Upcoming Indian Solar Mission

- 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



Lagrange points in the Sun–Earth system (not to scale).

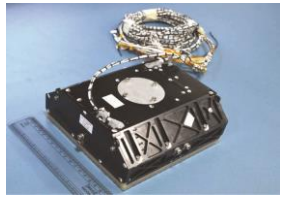


Upcoming Mission to Moon: Chandrayaan-3

Science Objective

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

- Lander, Rover with a Propulsion module.
- Landing at Southern high latitudes on the Moon.



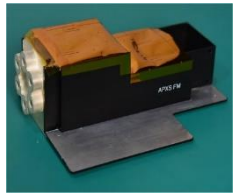
ILSA: Seismicity

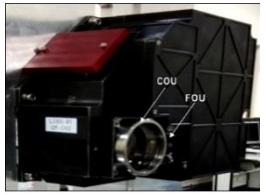
ChASTE: Thermophysical property of regolith

LANDER

Langmuir Probe: Lunar near-surface plasma environment

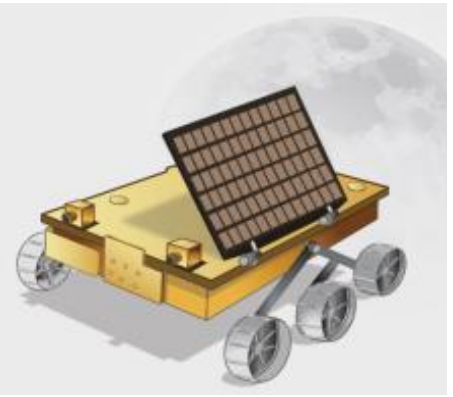
Lunar Retroreflector Array (NASA): Laser ranging to study Earth-Moon dynamics





Alpha Particle X-ray Spectrometer (APXS) & Laser Induced Breakdown Spectroscope (LIBS)

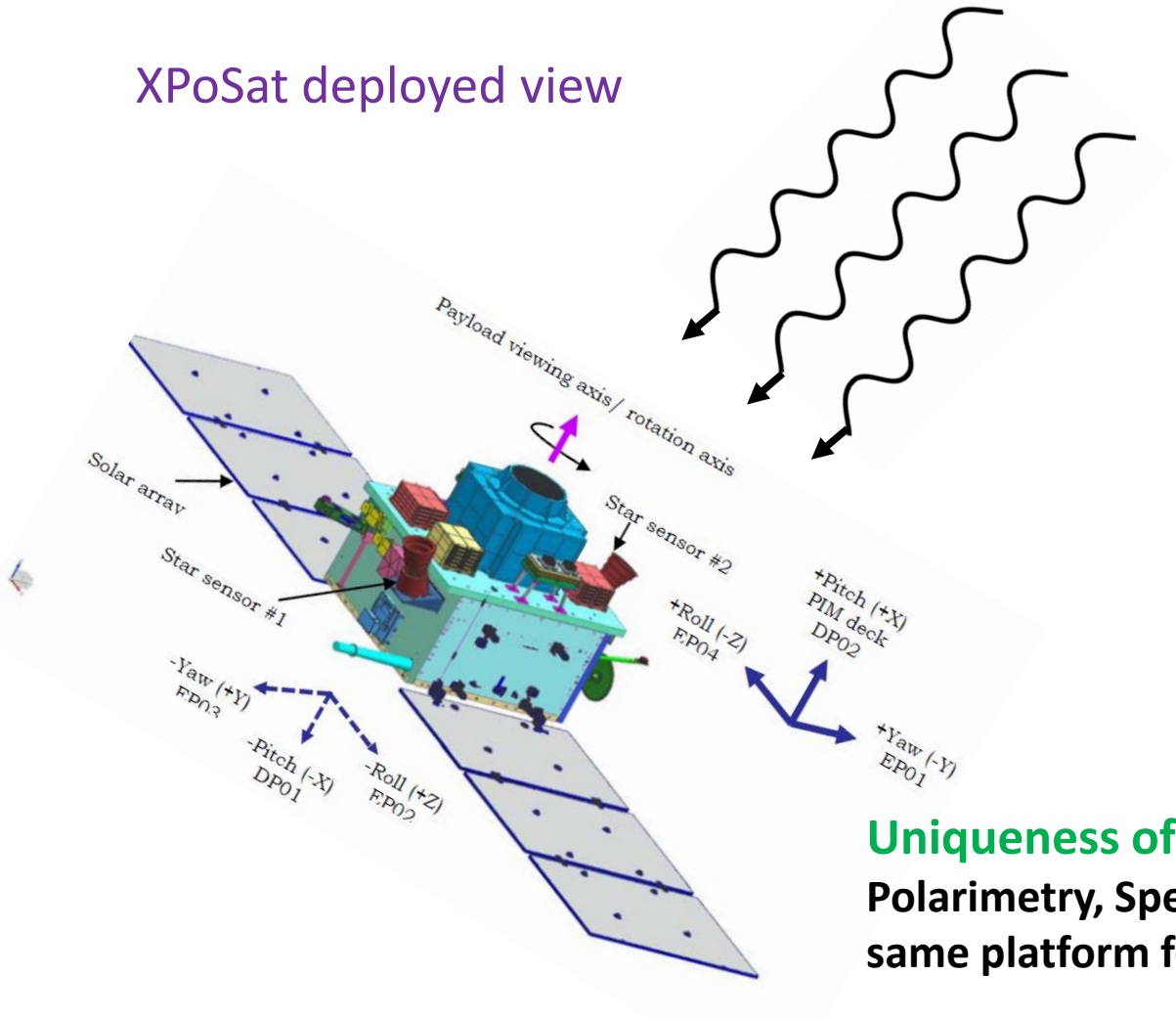
- To determine the elemental composition and abundance in the vicinity of the landing site.



Rover

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

XPoSat deployed view



First dedicated satellite for Polarization measurement in medium-energy X-rays.

Polarimetry is an important diagnostic tool of emission processes that are degenerate with respect to spectroscopic and timing information

XPoSat carries two payloads

- **POLIX** : **Pol**arimeter **I**nstrument in **X**-rays
  Will provide polarization information in the energy range 8-30 keV for bright astronomical sources.
- **XSPECT** : **X**-ray **Spect**rometer
  Will provide spectroscopic and timing information in the energy range 0.8-15 keV.

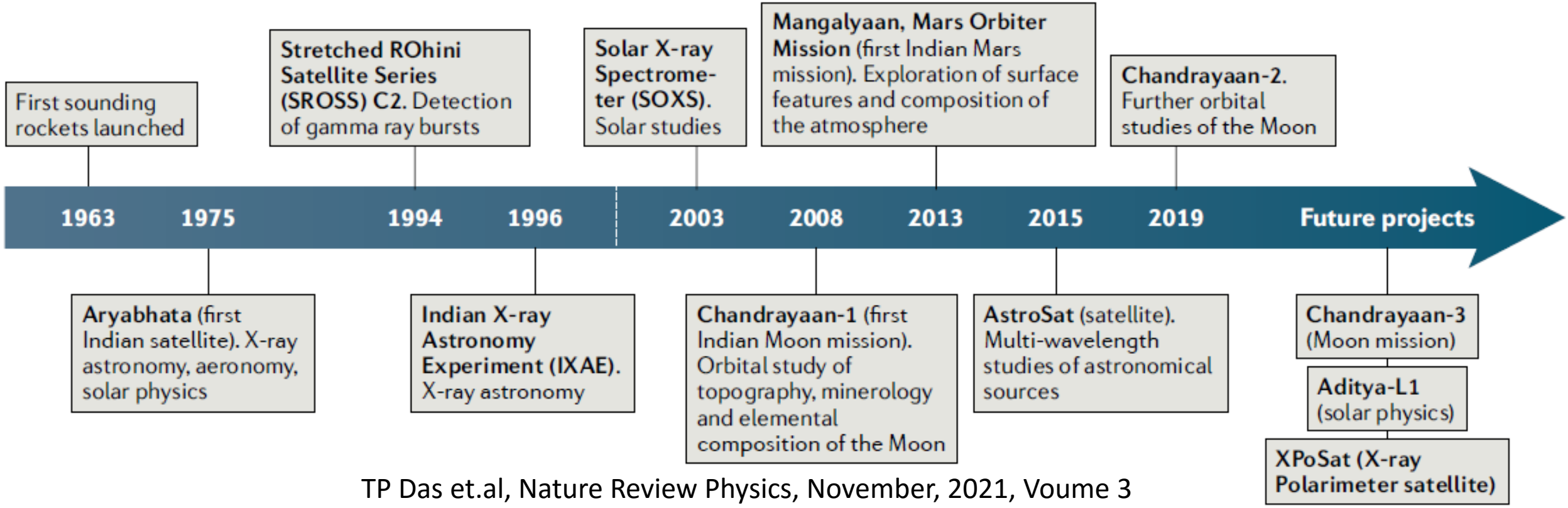
Uniqueness of the mission:

Polarimetry, Spectroscopy and Timing informations from the same platform for various bright astronomical sources in X-rays.

Repository of the Space Science Data

Accessible for public use: www. https://www.issdc.gov.in/

The Legacy



TP Das et.al, Nature Review Physics, November, 2021, Voume 3

Vision to Future

- Aeronomy during Quiet and Disturbed Solar Conditions
- Venusian Science and Sun-Venus Connection
- Integrated Space Weather Study
- Science from Space: Gaganyaan as a potential platform

International Cooperation in Space Sciences: Overview

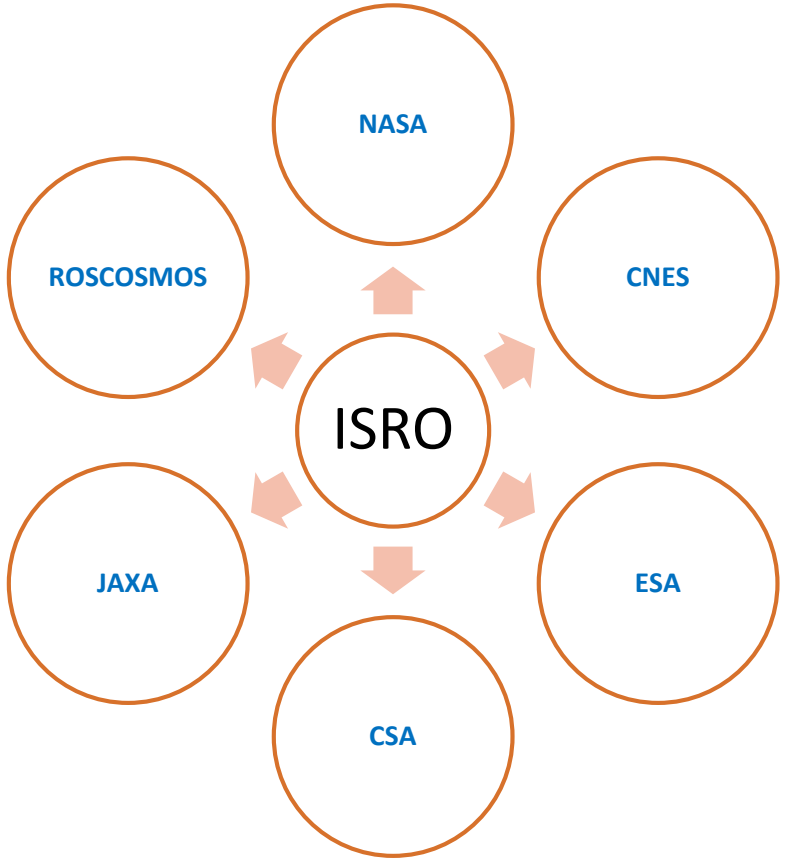
ISRO – NASA Planetary Science Working Group (INPSWG)

International Mars Exploration Working Group (IMEWG)

ISRO – NASA Heliophysics Working Group (INHWG)

Science Working Groups

Science Payload Cooperation



Planetary Exploration Joint Working Group (PEJWG)

Lunar polar exploration mission

Akatsuki RO experiment

Science Working Groups

Science Payload Cooperation

Future Astronomy missions

International Bodies like:

- **Committee on Space Research (COSPAR)**
- **International Space Exploration Coordination Group (ISECG)**
- **International Space Exploration Forum (ISEF)**

Take-home message

- ISRO's Space Science Exploration:
    1. Planetary Exploration
    2. Heliophysics & Space Weather Studies, including Aeronomy
    3. Astronomy & Astrophysics, including Exoplanets
- Missions discussed: Chandrayaan-1,2; Mars Orbiter Mission; AstroSat → Important Scientific Results
- Not covered in this lecture:
    1. Missions in pipeline
    2. Ground based space science
    3. Serendipitous observations: Science of the Sun from Moon and Mars Missions
- Collaborative efforts with National and International entities
- Engagement with academia and institutes; promotion of space science activities; International Cooperation
- Science data are available for public