

Indian Space Research Organization (Science Highlights)

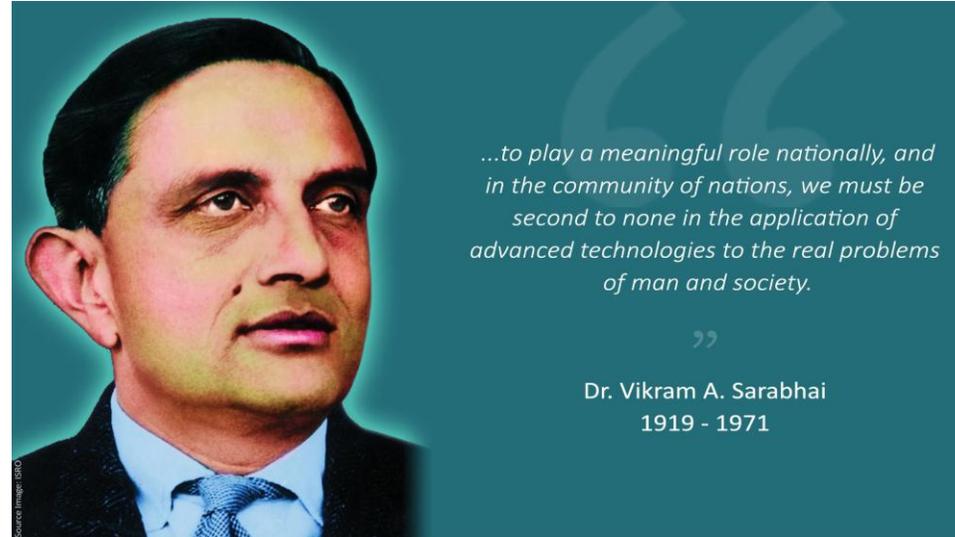
Presentation to the National Academy of Sciences – Space Science Week 2026
Washington DC, 24 March 2026



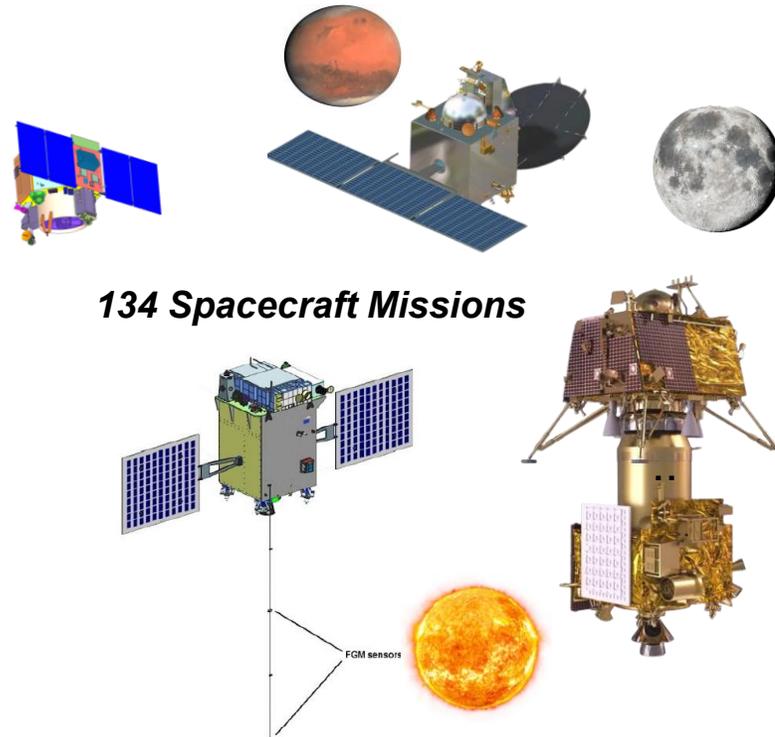
N. Lakshmi Narasimhan

Counsellor (Space), ISRO Technical Liaison Officer (ITLO),
Embassy of India, Washington DC

Indian Space Programme - Overview

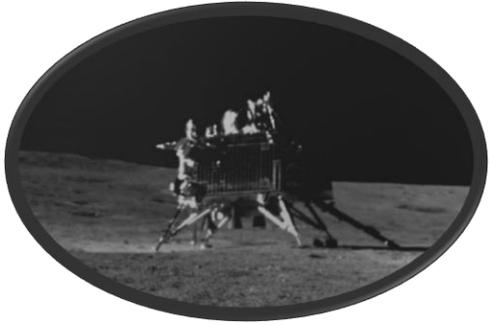


105 Launch Missions
434 Foreign Satellites Launched



Indian Deep Space Network

Recent Science Missions - Highlights



Chandrayaan-3 (2023)

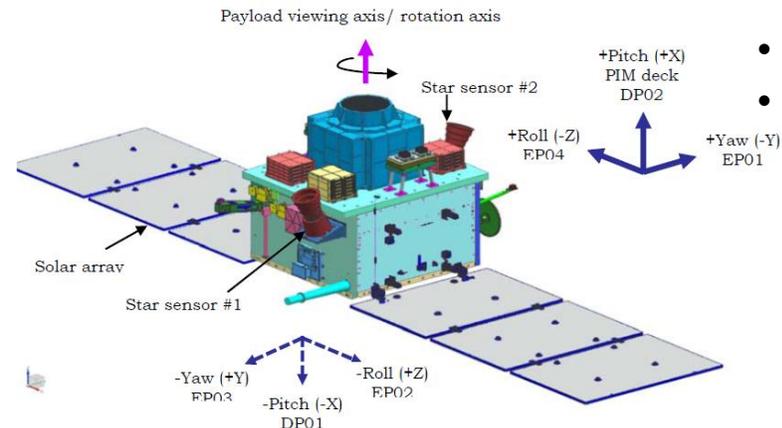
- Thermo-physical properties of first 10 cm of regolith
- Near-surface plasma
- Seismicity
- Elemental composition



Aditya-L1 (2023)

- India's first dedicated Solar Observatory
- First time: Sun-Earth L1 point from India
- Understanding: Sun, space-weather triggers
- Studied the solar storm in May, 2024

XPoSat (2024)



- India's first X-Ray Polarimetry Observatory
- Second in the world
- More insight into the astrophysical processes of Black Holes, X-Ray Pulsars, Neutron Stars and other luminous X-Ray sources

NISAR (2025)



- Joint mission by ISRO and NASA
- Maps the entire globe in 12 days
- Dual band Synthetic Aperture Radar (SAR)
- Sweep SAR technique to achieve large swath with high resolution.
- Launched on 30 July 2025 from India

Recent Key Scientific Achievements

Release of higher level Ch-2 data products (through ISSDC) on surface hydration and mineralogy in lunar South Polar Region.

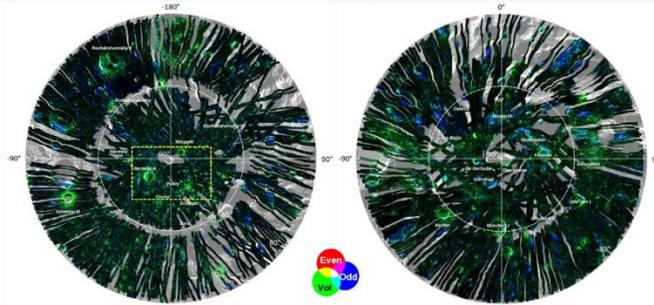


Figure: Radar Polarimetric Decomposition Maps of Lunar North (left) and South (right) Pole

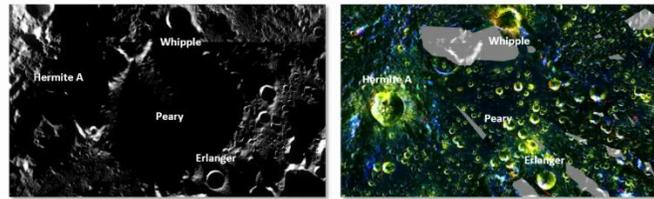
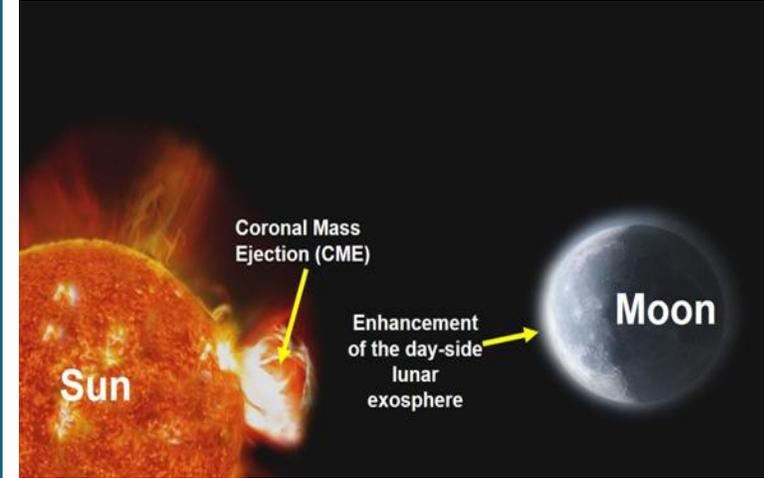
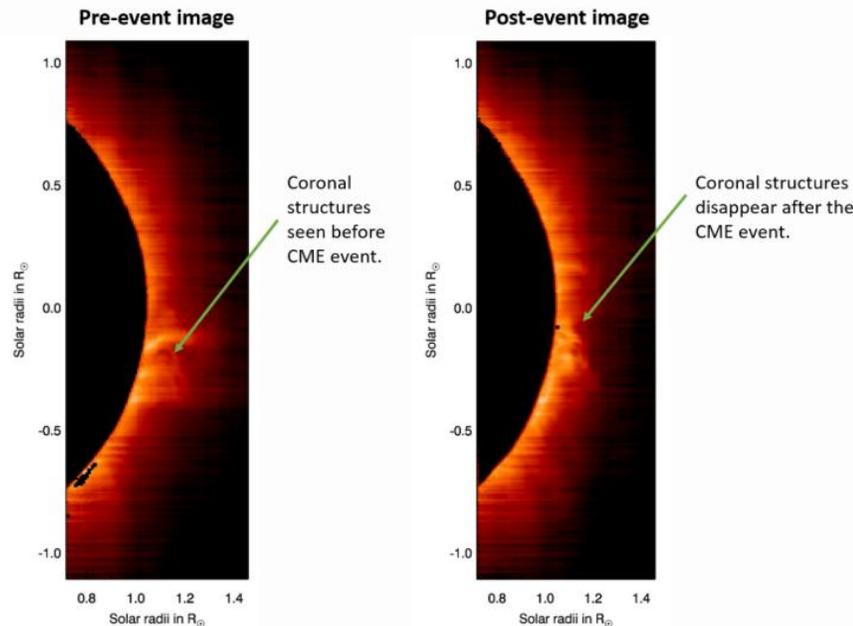


Figure: (Left) Optical and (Right) DFSAR Image of Peary Crater region in Lunar North Pole, from a section marked on the mosaic

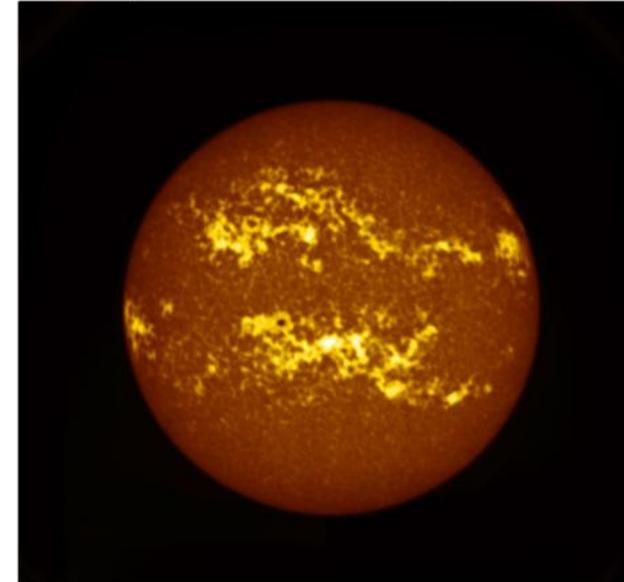


First-ever observation of Coronal Mass Ejections on Moon's exosphere using CHACE-2/ Chandrayaan-2 data.

Observation of Coronal Dimming by VELC/ Aditya-L1



NB4 MgII h 280 nm 2024-May-17 05:20:26

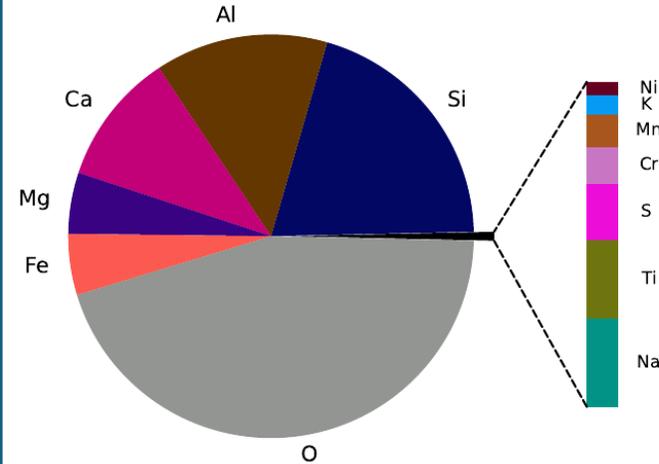


First-ever capture of the full solar disc in NUV wavelengths.

Recent Key Scientific Achievements

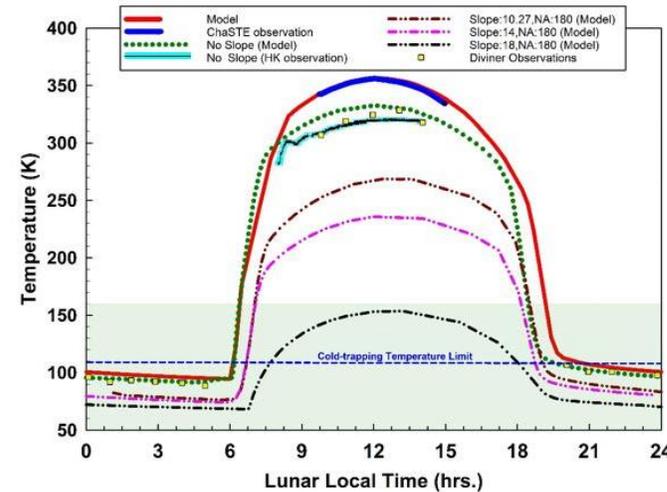
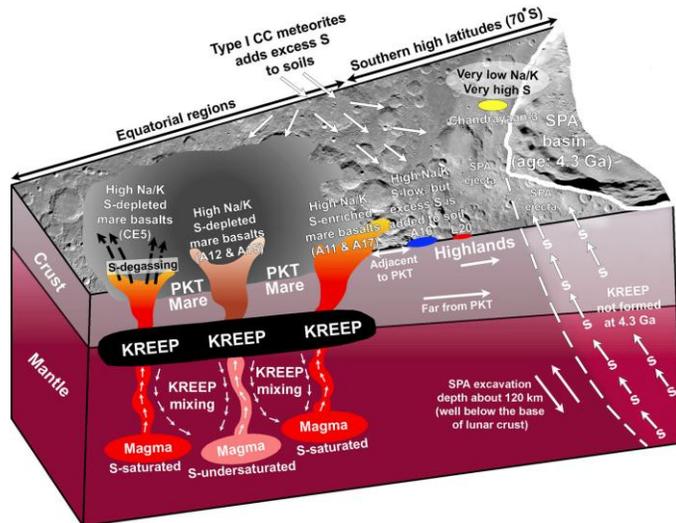


First-ever characterization of the near-surface lunar plasma, at Southern high latitudes by RAMBHA-LP/Ch-3. Electron density found much higher than expected.



Detected by APXS/Ch-3:
 Presence of major & minor elements
 → Major: Si, Al, Ca, Mg, and Fe
 → Minor: Ti, S, Cr, Mn, Ni, K, and Na
 → Almost no variation over the terrain

Presence of primitive mantle materials at the Shiv Shakti station - inferred from the Chandrayaan-3 APXS measured volatiles abundance.

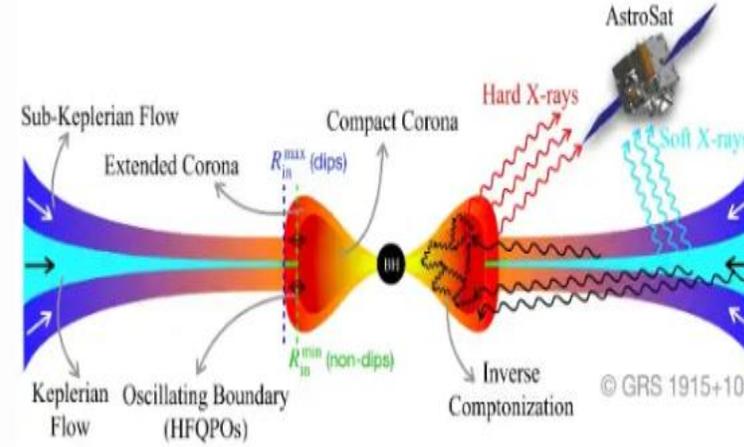
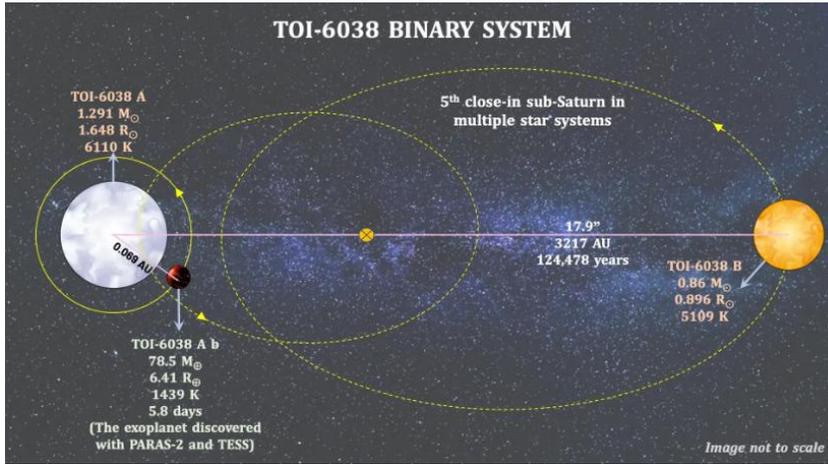


First-ever in-situ measurements of the temperature profile was made and thermophysical properties within the top 10 cm of the lunar surface at a high latitude south polar landing location made by CHaSTE/Ch-3.

Recent Key Scientific Achievements

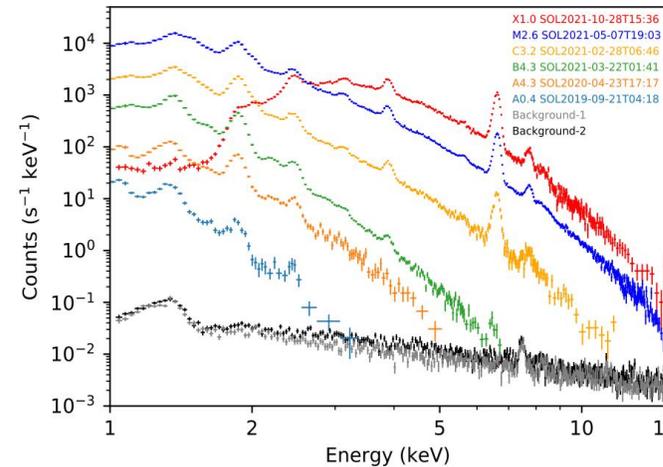
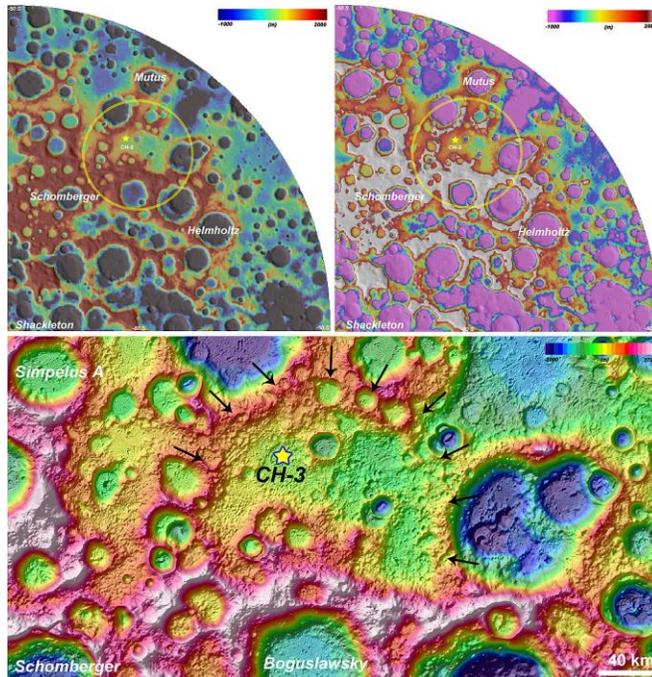


PARAS-2 spectrograph, at PRL's Mount Abu Observatory, discovered a new exoplanet (TOI-6038A b).



Detection of quasi-periodic oscillations from a black hole using LAXPC and SXT of AstroSat

Discovery of a large buried crater, hosting the Chandrayaan-3 Landing site, which is likely older than the South Pole Atkin basin

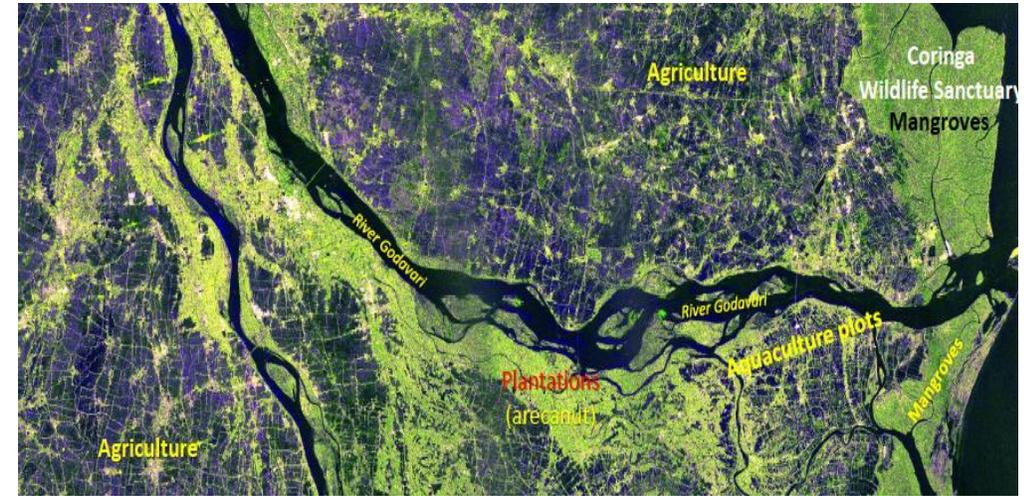
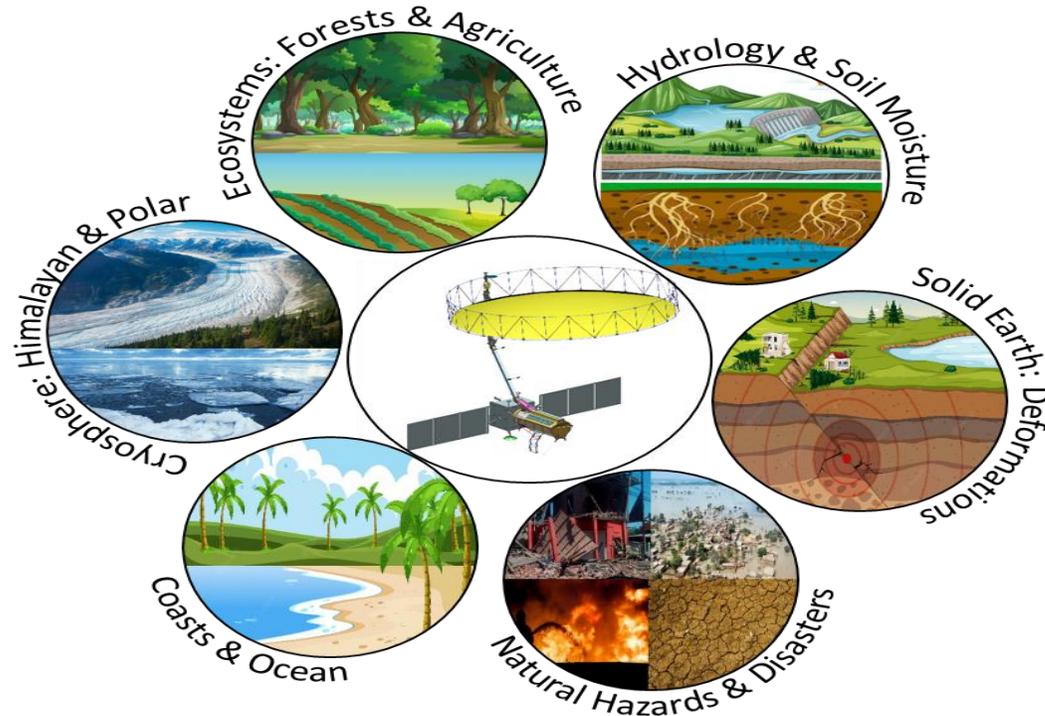


- World's best solar X-ray spectrometer
- First detection of large number of Sub-A class microflares in the Quiet Sun
- First measurements of abundances of low FIP elements in the Quiet Sun

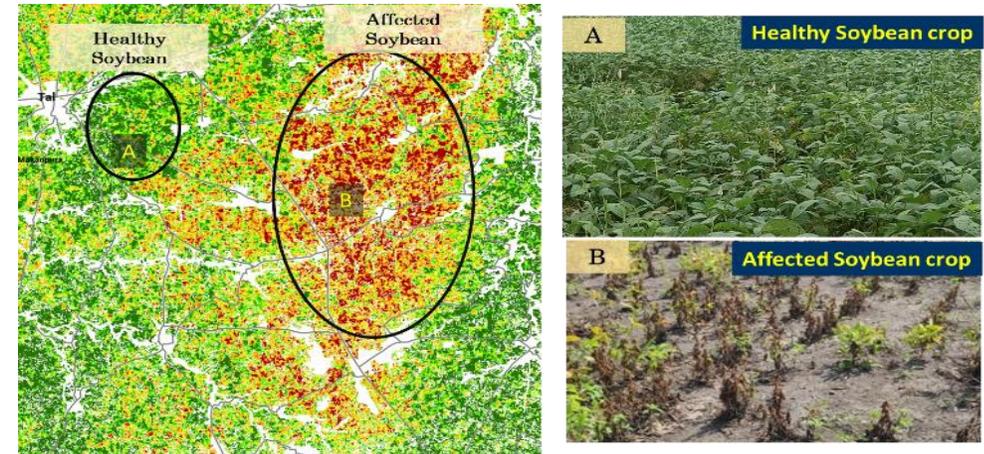
NISAR : NASA-ISRO SAR MISSION

Commissioning Phase completed, Science Calibration activities in progress

Major Science Themes



First image of S-band SAR acquired on 19th Aug 2025 (Godavari Delta, Andhra Pradesh, India) showing Mangroves, Agriculture, Arecanut plantations, Aquaculture fields, etc



NISAR S-band data (HH) showing discrimination of healthy and stress Soybean in Madhya Pradesh

- ❑ Since the first acquisition on 19th August, 2025, NISAR S-Band SAR is regularly imaging Indian Landmass and Global Calibration-Validation sites.
- ❑ NISAR completed 100 days in-orbit on 07th November 2025.
- ❑ S-SAR products are being catalogued at Bhoonidhi (ISRO's EO data dissemination portal).

How to access Indian Space Exploration Data?



<https://issdc.gov.in>



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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A+ A A- हिंदी



Indian Space Science Data Centre (ISSDC) [issdc.gov.in] archives the data from ISRO's science missions

UPCOMING MISSIONS

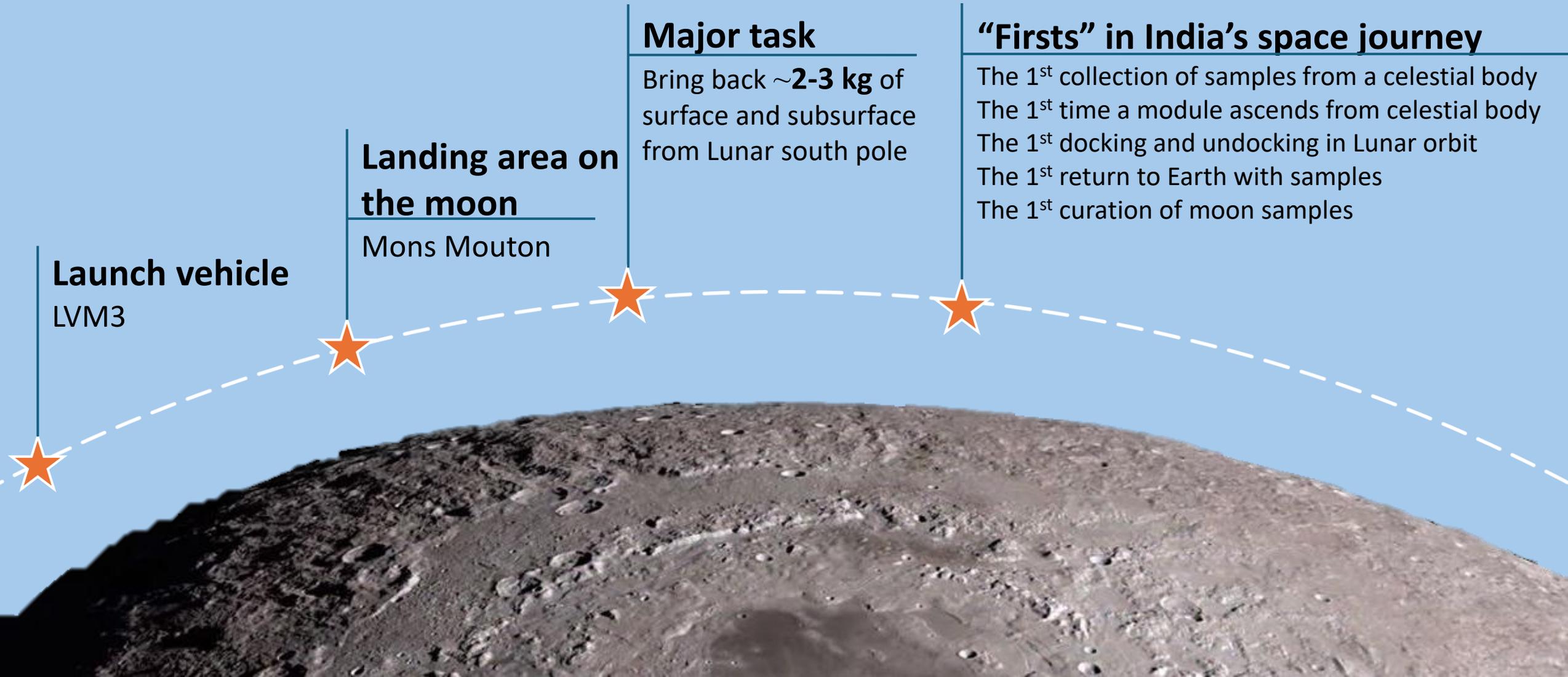
Lunar Exploration

Mission to Venus

Earth Observation & Meteorology

CHANDRAYAAN-4

Lunar Sample Return Mission



CHANDRAYAAN-4

Configuration and Objectives



Ascender Module

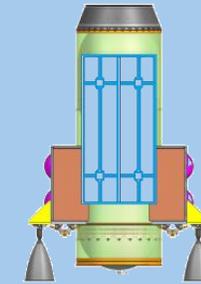


Descender Module

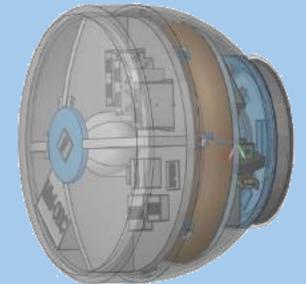


LVM-3

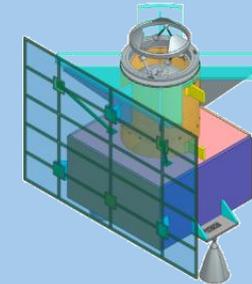
- Demonstrate docking in Earth elliptical orbit
- Perform safe and soft landing on Lunar surface
- Demonstrate Lunar sample return and containerization
- Demonstrate ascent from Lunar surface
- Demonstrate docking and undocking in Lunar orbit
- Demonstrate transfer of samples from one module to other
- Demonstrate return and re-entry to Earth for sample delivery



Propulsion Module



Re-entry Module



Transfer Module



LVM-3

Mission Life

Launch to Sample return: < 6 months ; On Moon: 1 Lunar day (max.)

CHANDRAYAAN-5

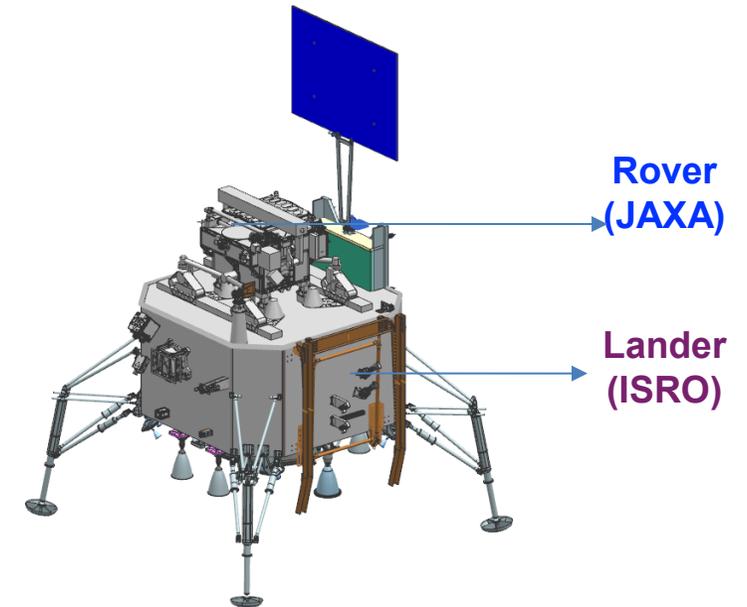
Lunar Polar Exploration (LUPEX)

Objectives:

- Safe, soft & precise landing in Lunar south pole
- Deployment of ~400 kg Rover (JAXA)
- In-situ Scientific Experiments :
 - Water Scouting at polar region
 - Studies in Permanent Shadow Regions (PSR)

- Lift-off Mass : 6650 kg (Heaviest among ISRO spacecraft)
- Landing mass : 2200 kg (Ch3: 800 Kg)
- Launch vehicle : H3 24L
- Landing Site : CR1 (*Connecting Ridge-1 @ 89.4 deg S*)
- Mission life : 100 days on Moon

New Technologies: Higher capability structure, High power Engines with throttling capability, Advanced Sensors, Integrated Avionics, New deployment mechanisms, Payloads for characterising Lunar Regolith...



Launch Vehicle (JAXA)



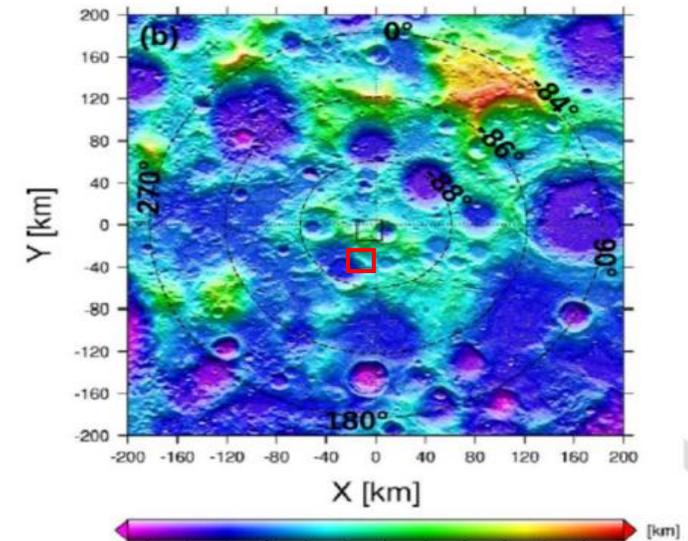
Uniqueness

- First-ever Mission to
 - ❑ Land **closest ever to south pole** (Crater Ridge - CR1): (*CR1 is a rare higher illumination zone at South pole*)
 - ❑ Carry out robotic exploration of a **Permanently Shadowed Region (PSR)**
 - ❑ **To study lunar regolith up to 1.5m deep.**
- **Chandrayaan-5 to serve as a precursor for Long duration** Lunar missions and habitats
- To provide invaluable experience in handling larger lander (key for Lunar landing).

Science Objectives

- ❖ Obtain data regarding water quantity and quality to aid evaluating whether lunar water can be utilized in future exploration activities.
- ❖ Understanding lunar water accumulation mechanisms, estimate quantity and quality of water across polar region, identify water-rich sites.
- ❖ Obtain data on the polar landing site surface composition including volatiles to understand their properties.

	CY-3	CY-5
Landing location	~ 69° S	~ 89.4° S
Mission life	14 days	100 days
Landing Mass	800 Kg	2200 kg
Rover Carried	25 Kg	~400 kg

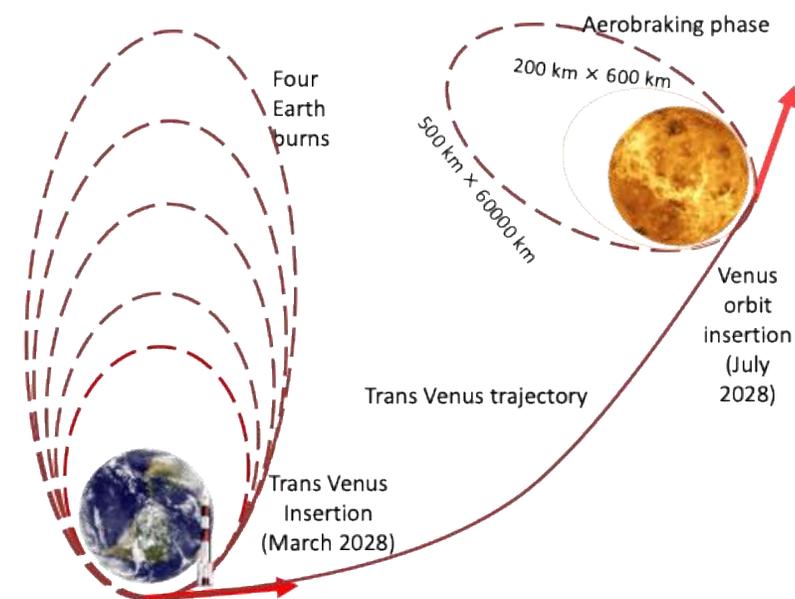
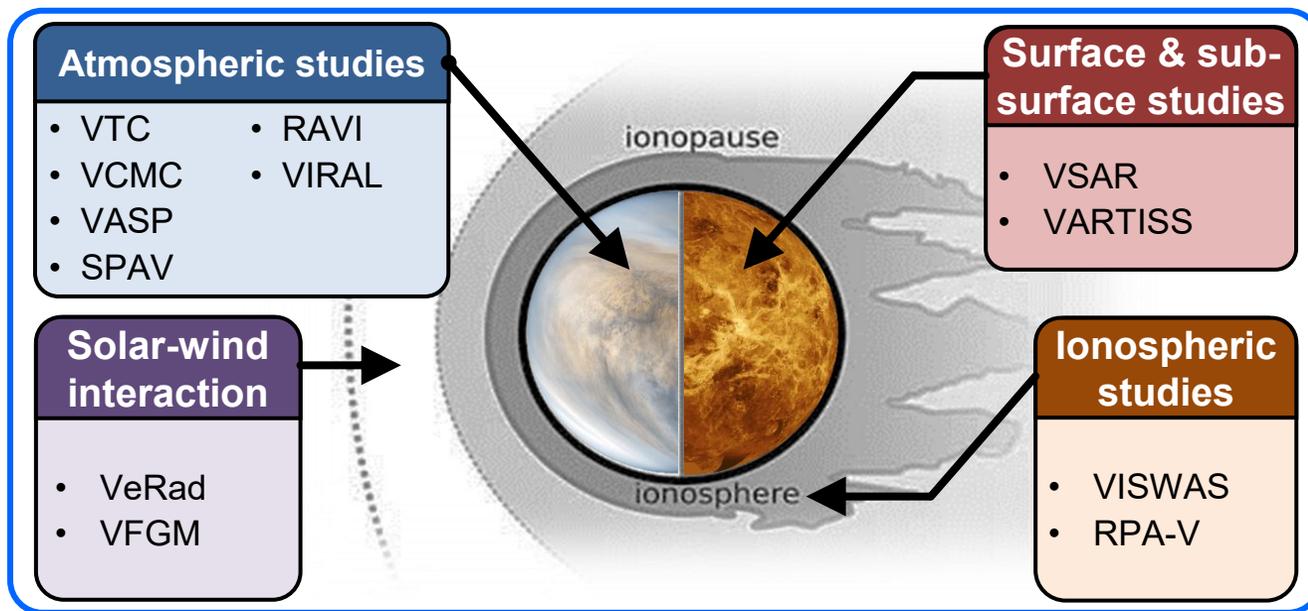
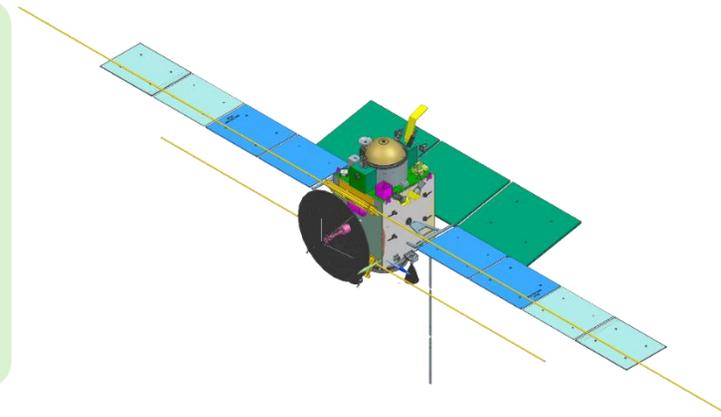


Landing on the Ridge between two craters 'Shackleton' & 'de Gerlache'

VENUS ORBITER MISSION

Mission objectives:

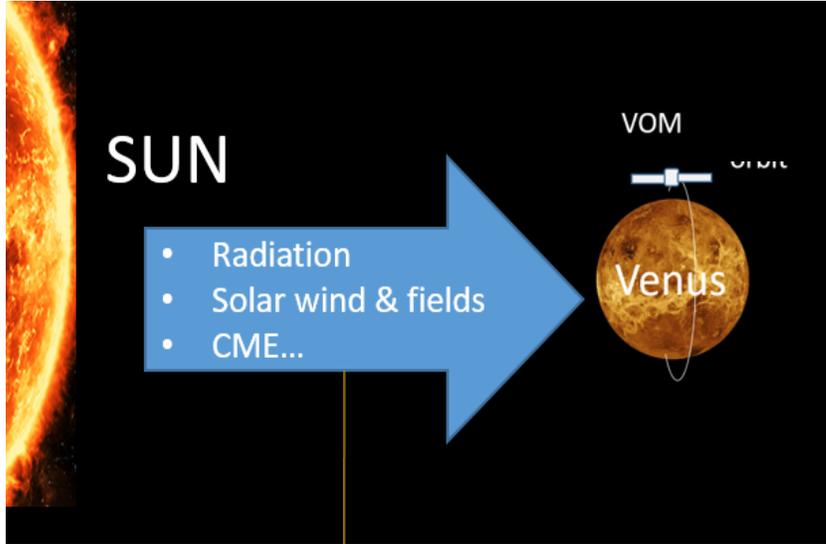
- Enhance the knowledge of the composition, circulation and evolution of the atmosphere of Venus
- Understand the surface and sub-surface properties of Venus.
- Examine and understand the interaction between the solar wind and Venusian ionosphere
- Mission will serve as a technology demonstration for ISRO, testing aerobraking and thermal management techniques in the harsh Venusian environment



Scientific payloads: 10 indigenous; 2 International

VENUS ORBITER MISSION

Major Science Objectives Identified



**Venus System Science →
Venusian Science +
Sun-Venus Interaction**

Surface and sub surface

- **Geologic and resurfacing history**
- **Impact processes and detect buried Impact craters**
- **Vertical structure and stratigraphy of geological units**
- **Refined global topography**

Atmosphere

- **Dynamics**
- **Structure**
- **Composition**
- **Cloud Characteristics and Dynamics**
- **Lightning**
- **Aerosols & Hazes**

Venus Solar wind interaction

- **Ionospheric dynamics & Plasma Waves**
- **Interaction of solar wind**
- **Field & Radiation environment**

Thermal infraRed Imaging Satellite for High-resolution Natural resource Assessment

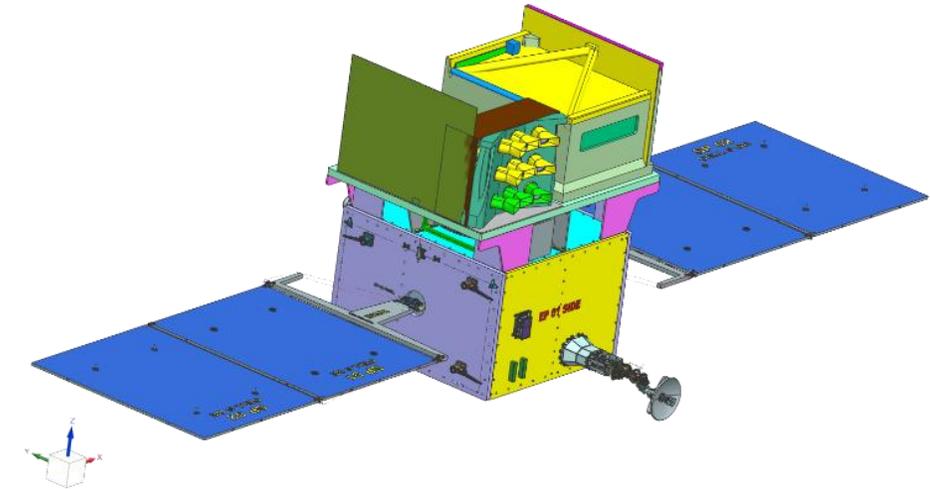
TRISHNA satellite will have two instruments - Visible and Near Infrared/ Short Wave Infrared sensor (VSWIR) from India (ISRO) and Thermal Infrared Instrument from France (CNES).

Objectives:

- ❖ Water management (Agriculture,
- ❖ Ecosystem (health, drought, fire)
- ❖ Coastal and inland water monitoring
- ❖ Cryo-sphere
- ❖ Urban heat island monitoring and solid earth/volcanology

Highlights:

ISRO	:	VSWIR Instrument + Bus + Launch Vehicle
CNES	:	TIR Instrument
Altitude	:	761 km (SSPO)
Launcher	:	PSLV
Revisit time	:	3 Days, geometric revisit - 8 days



Higher resolution (~ 60m), 3-day revisit

4th Generation Meteorological Satellite

Proposed Instruments on INSAT-4th Gen to enhance capability to provide nowcasting to very short range prediction:

❑ Advanced Imager

Temporal Resolution: Every 15 minutes

1 Full Disk (15 minutes); 3 Indian Land mass (5 minutes) and 30 Mesoscale images (30 sec)

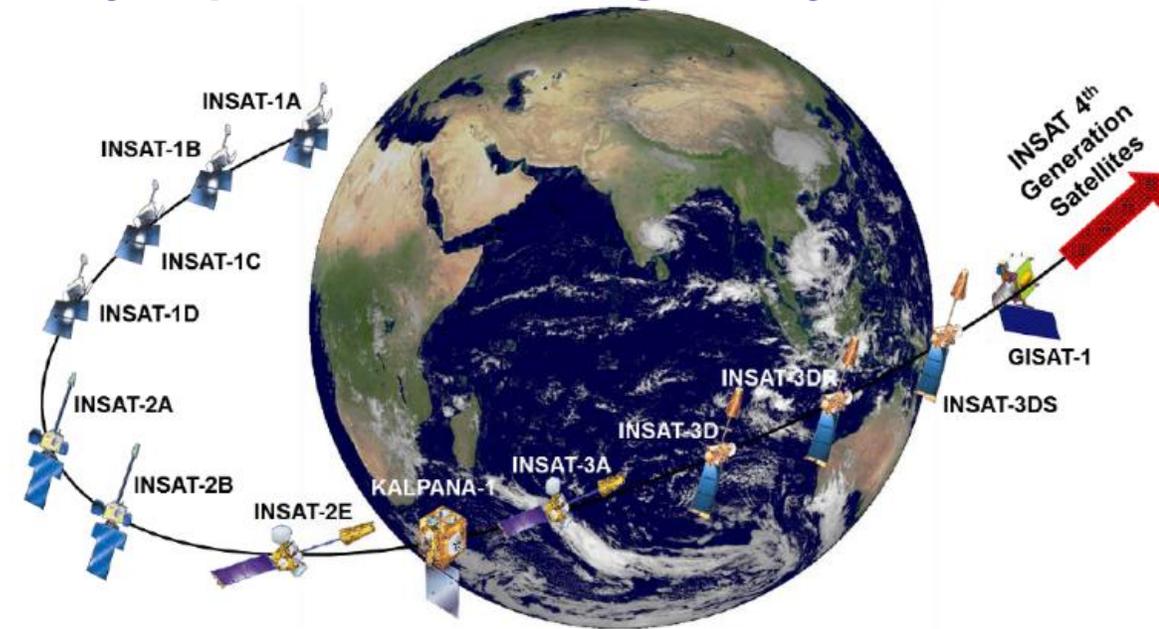
❑ Lightning Imager

Temporal resolution: 1 - 2 m-s frame rate (500-1000 frames/s)

- Maximum expected lightning events rate over the actual region: 20-25 events/second
- Latency requirements (Detection to processing): < 1 min
- Lat (0° - 45° N) and Lon (50° - 110° E) bounds of the Indian region to be covered by lightning Imaging payload.

❑ Hyper Spectral Infrared Sounder

- ~ 800 channels in LWIR & ~ 1000 channels in MWIR
- Temperature profile: 0.5-1.5 K in 1 km layer
- Humidity profile: 10-20% in 2 km layer



ISRO took part in the GeoXO Data Assimilation Workshop by NOAA in early March 2026

OTHER DEVELOPMENTS

Human Spaceflight

GAGANYAAN & SPACE STATION

Human Space Capabilities for long duration stay in space

Phase-I

Gaganyaan Missions

Phase-II

Precursor Missions for BAS

Phase-III

Operational BAS

Phase-IV

Indian Landing on Moon

Focus : Basic Capabilities for crew transportation to LEO & safe return



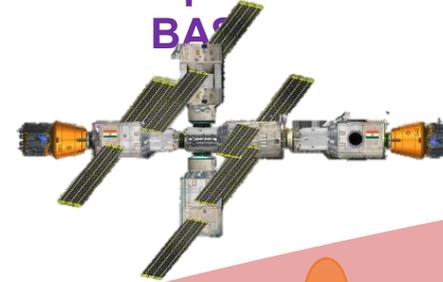
Gaganyaan

2026

1st Module of Bharatiya Antariksh Station (BAS)

2028

Focus: Crew habitation for medium/long duration space capabilities

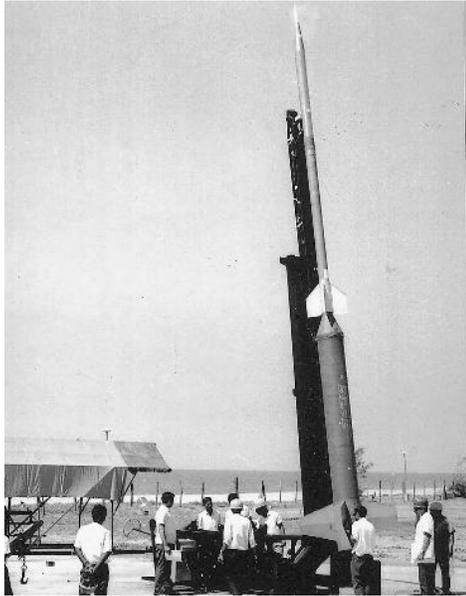


2035

Five module BAS

2040
Moon Return Module





Nike Apache

Thank You



NISAR



Details of Space Science accomplishments

Extra slides

Near-Surface Plasma on Moon

Major Findings

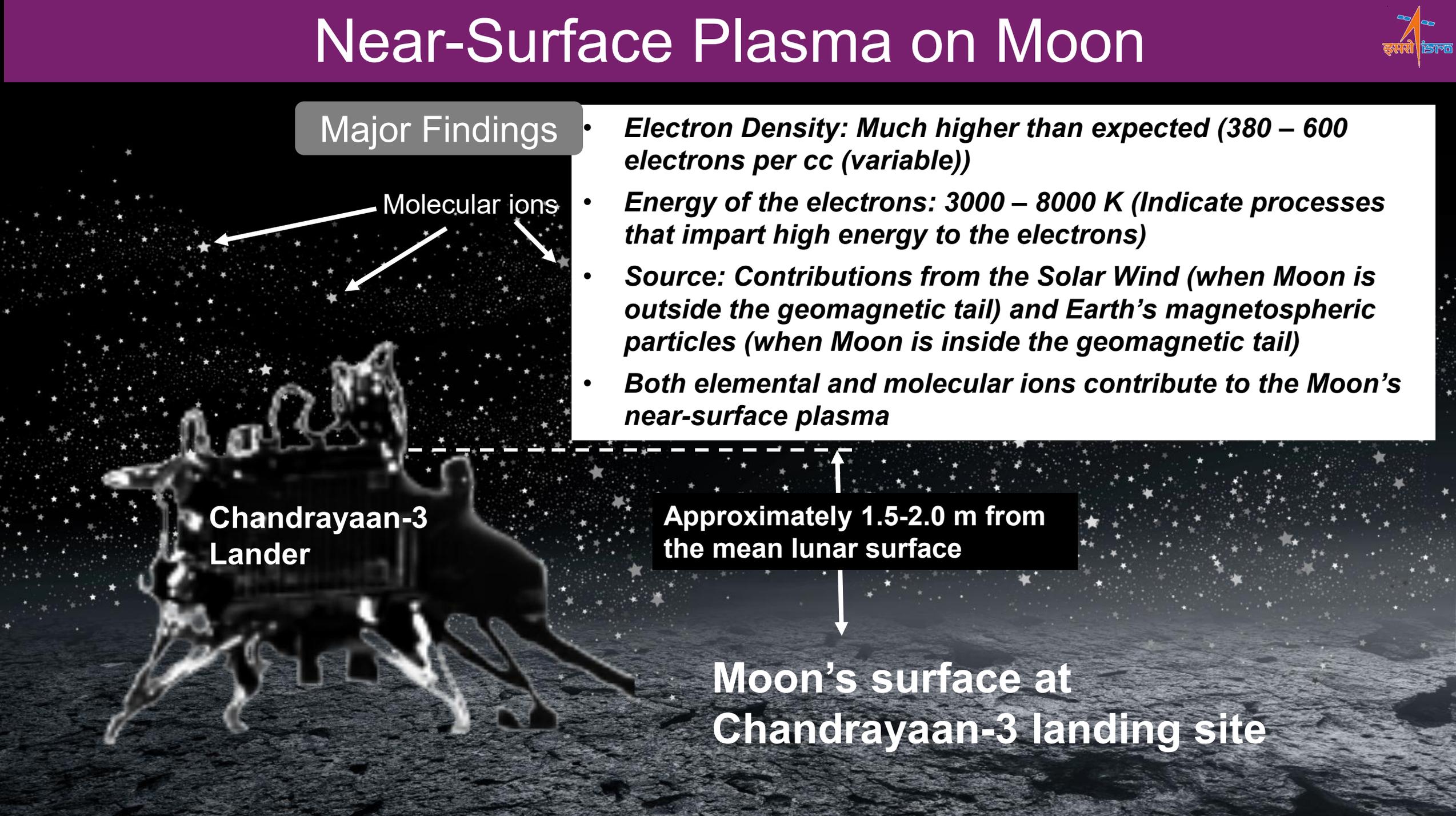
- **Electron Density:** Much higher than expected (380 – 600 electrons per cc (variable))
- **Energy of the electrons:** 3000 – 8000 K (Indicate processes that impart high energy to the electrons)
- **Source:** Contributions from the Solar Wind (when Moon is outside the geomagnetic tail) and Earth's magnetospheric particles (when Moon is inside the geomagnetic tail)
- **Both elemental and molecular ions contribute to the Moon's near-surface plasma**

Molecular ions

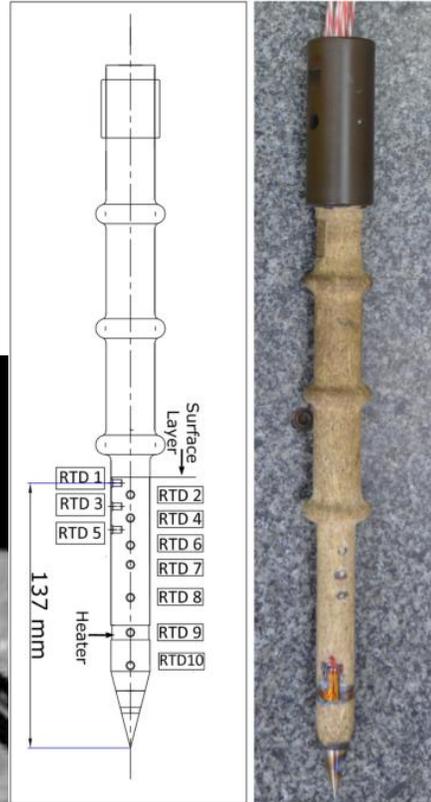
Chandrayaan-3
Lander

Approximately 1.5-2.0 m from
the mean lunar surface

Moon's surface at
Chandrayaan-3 landing site



Temperature of Moon's Epi-Layer (first 10 cm)



Major Findings

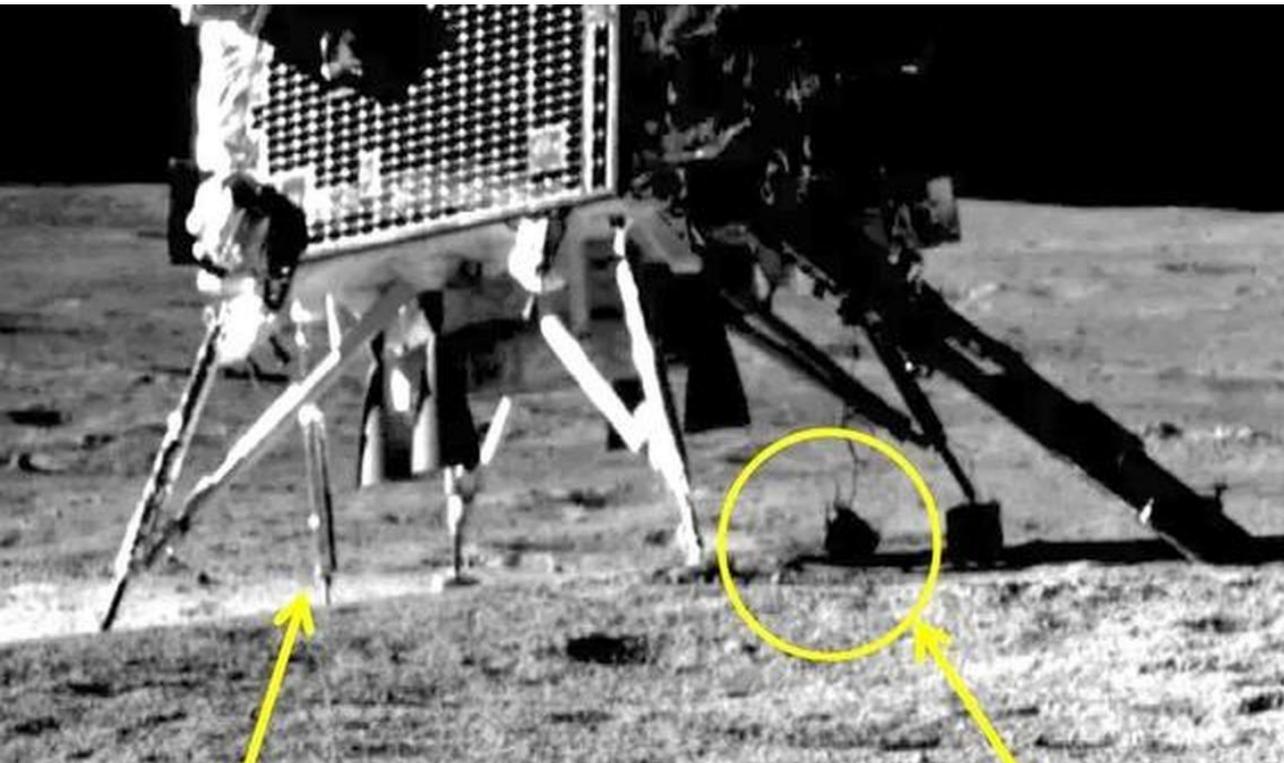
- CHASTE Thermal probe investigated the temperature profile and thermophysical properties within the top 10 cm of the lunar surface.
- The peak surface temperature : 355 K (± 0.5 K): About 25 K higher than speculated
- Lunar surface temperatures show a significant spatial variability at metre scales at high latitudes, unlike at the equatorial regions.

CHASTE

ILSA

Vibrations of the Moon's Ground

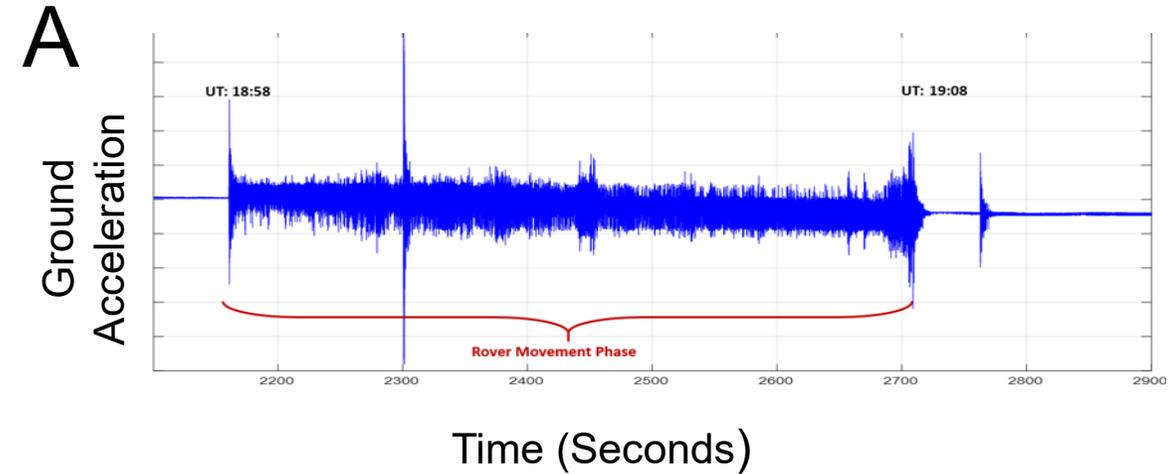
Major finding: Polar regions of the Moon are not seismically quiet. Vital inputs for building infrastructure and habitats on the lunar surface.



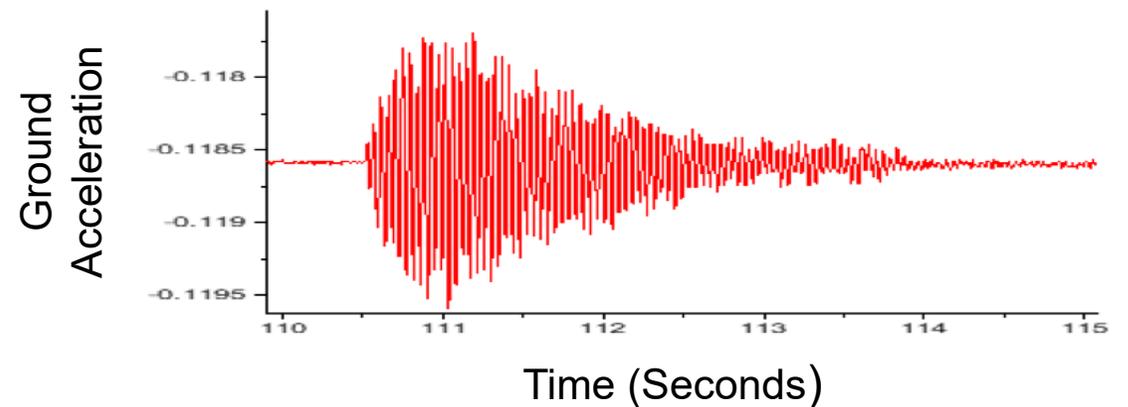
CHASTE

ILSA

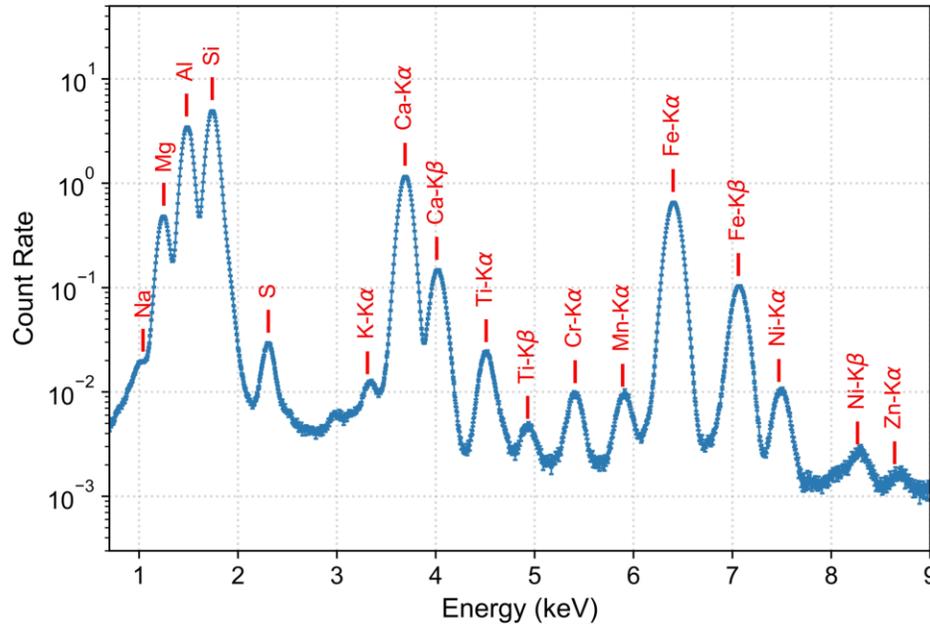
Navigation of rover on 25/08/2023. Distance of rover from ILSA was ~ 11 meters



B One of the seemingly natural events



Measurements by the Chandrayaan-3 Rover



APXS spectrum. Characteristic lines of detected major and minor elements are marked.



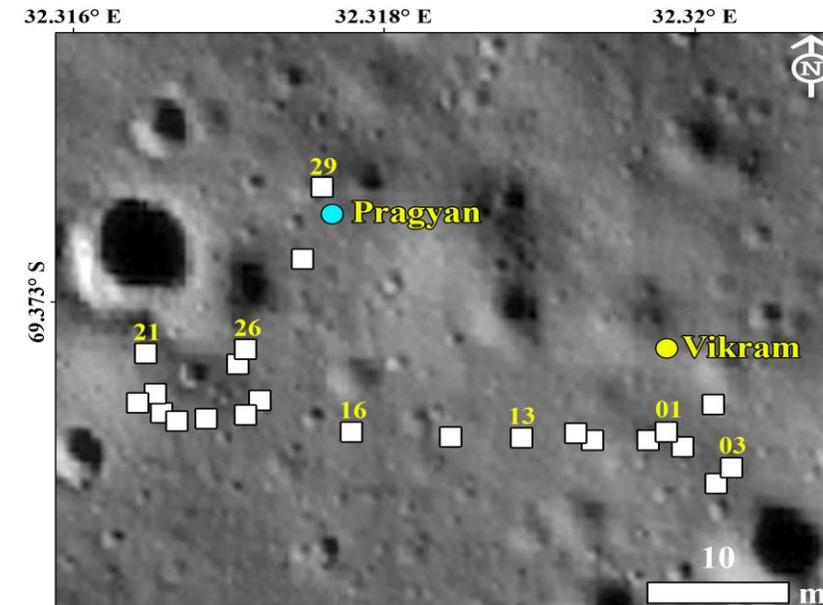
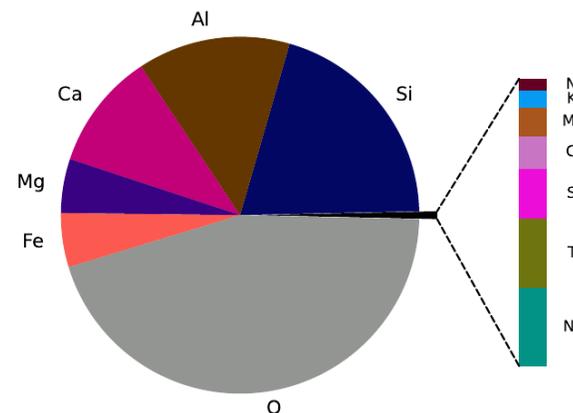
Alpha Particle X-ray Spectrometer (APXS) on Chandrayaan-3 Rover

Energy Range : 0.8 – 25 keV
 Resolution : < 150 eV @ 5.9 keV
 Exciting source : Cm-244 Alpha (6 x 5 mCi)

Major Findings

Presence of major & minor elements

- Major: Si, Al, Ca, Mg, and Fe
- Minor: Ti, S, Cr, Mn, Ni, K, and Na
- Almost no variation over the terrain



Vadawale, et al. + Bhardwaj, *Nature* (21 August 2024)
<https://doi.org/10.1038/s41586-024-07870-7>

Capturing the Solar Eruptive Events: May 2024

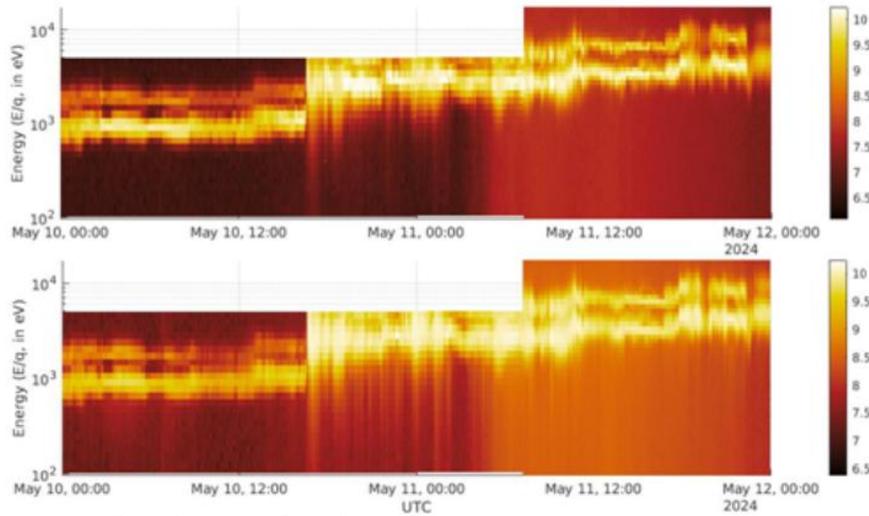


Figure 1: Proton (lower) and alpha (upper) lines are seen from the THA-1 and 2 SWIS observations. The prominent change in the flux is noticed as the signature of this solar eruptive event. The upper and lower panels represent the observations from THA-1 and THA-2 of the SWIS. The colour bar represents the raw counts, in log scale.

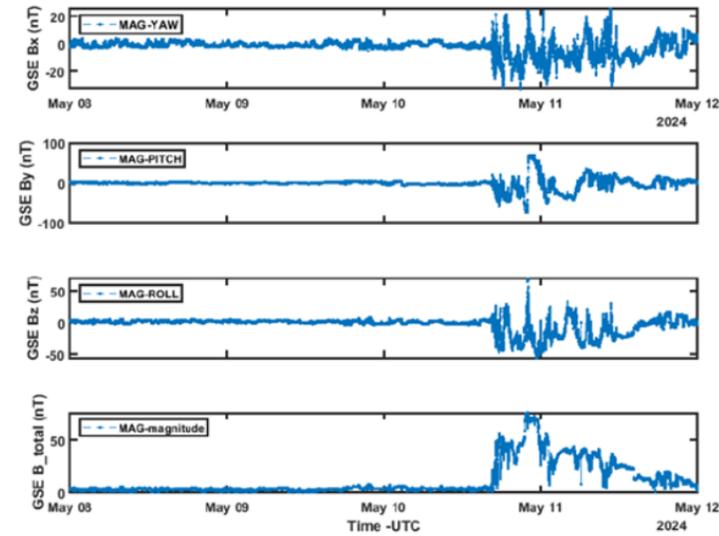


Figure 5: The measurements with the MAG payload has captured the perturbations in the Interplanetary Magnetic Field (IMF) caused by the solar eruptions.

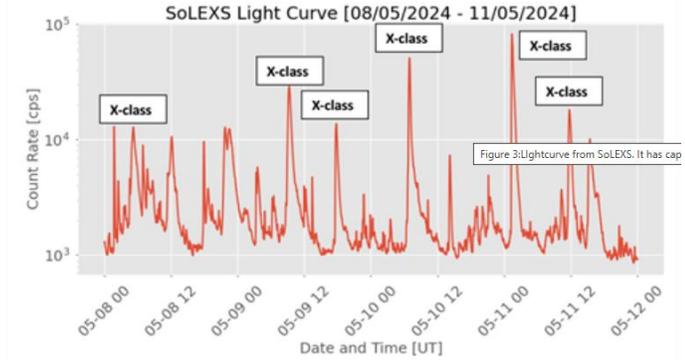
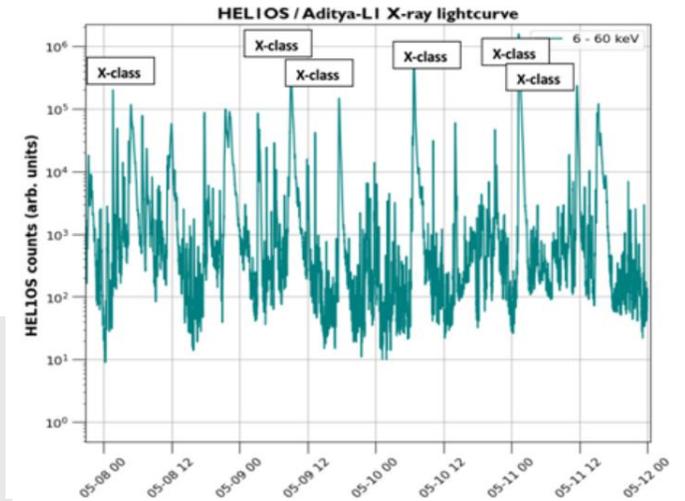


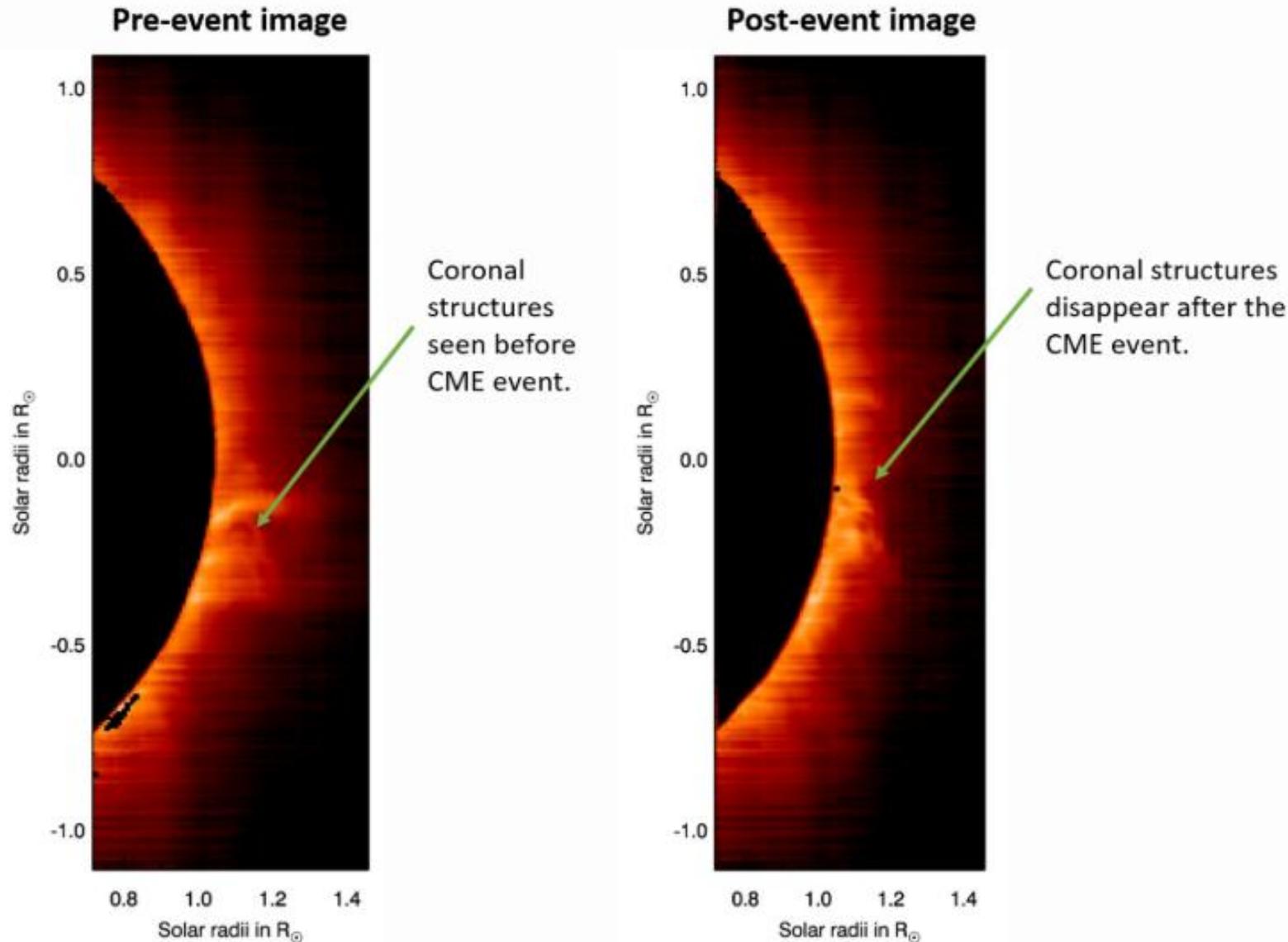
Figure 3: Lightcurve from SoLEXS. It has cap



Major Findings

- **Intense Solar Activity:** Sunspot region AR13664 emitted numerous powerful X-class and M-class solar flares and Coronal Mass Ejections (CMEs)
- **Geomagnetic Storm:** May 11, 2024.
- **Aditya-L1 Observations:**
 - ✓ Remote sensing instruments (SoLEXS and HEL1OS) on Aditya-L1 observed the flares and CMEs directly on May 8-9, 2024.
 - ✓ In-situ instruments (ASPEX and MAG) on Aditya-L1 detected the storm's impact at the L1 Lagrange point on May 10-11, 2024

First Ever: Close Observation of a CME



Major Findings

- **Coronal Dimming:** A 50% decrease in coronal brightness occurred for approximately 6 hours
- **Increased Temperature and Turbulence:** The CME region experienced a 30% temperature increase and heightened turbulence,
- **Plasma Ejection and Deflection:** Redshifted Doppler velocity measurements (10 km/s) indicate plasma moving away

First-ever: Full Solar Disc Image in UV

NB3 MgII k 279 nm 2024-May-17 05:20:48

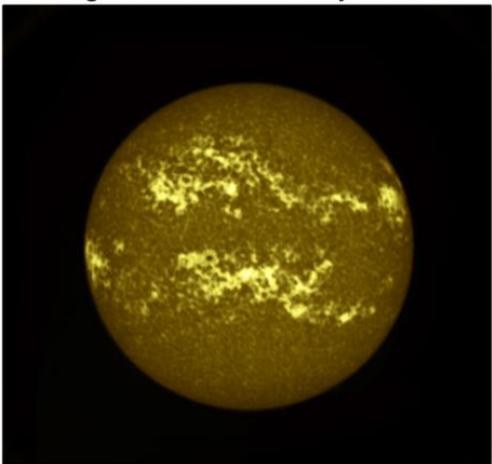


Fig. 1

NB2 276 nm 2024-May-17 05:21:30

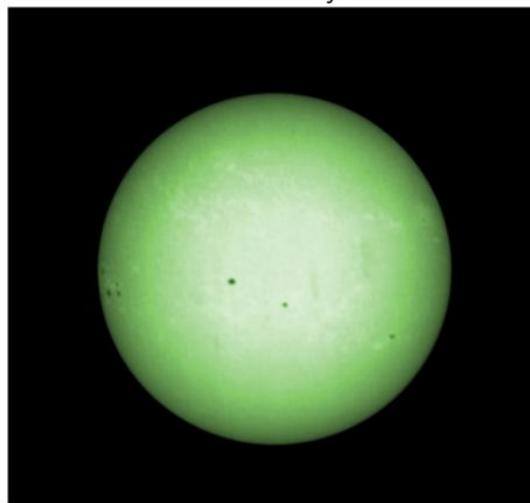


Fig. 3

NB4 MgII h 280 nm 2024-May-17 05:20:26

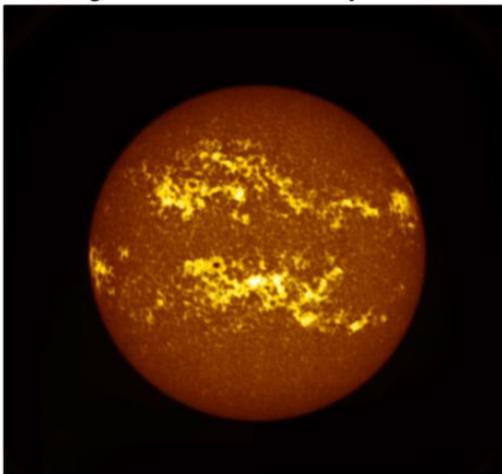
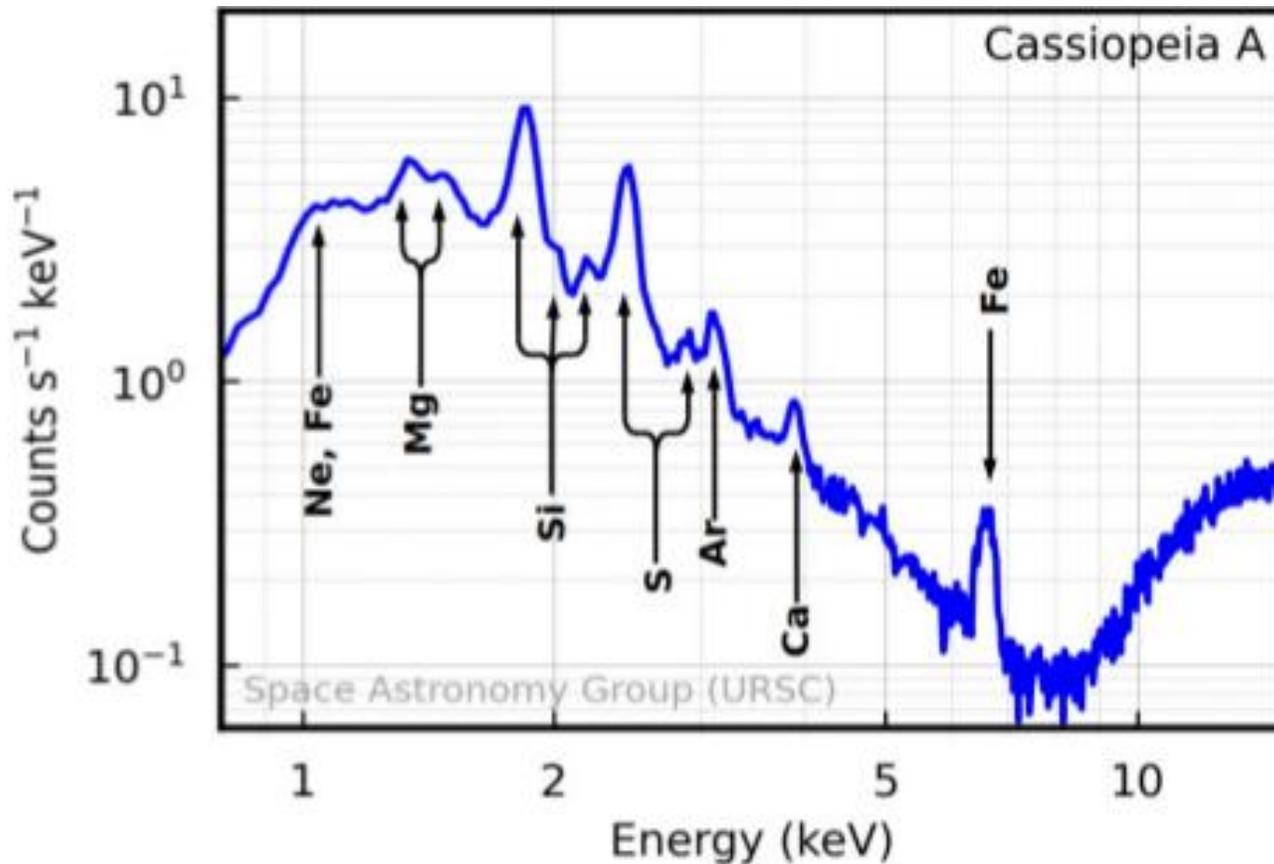


Fig. 2

Major Findings

Solar Images	Wavelength	What It Observes	Why It's Useful	Unique Science Areas
Figure 1	Mg II k	A layer above the Sun's surface called the chromosphere	Helps study solar flares and energy distribution;	Studies how the solar flares heat up the chromosphere and how the energy is deposited
Figure 2	Mg II h	Same as Mg II k, in the chromosphere	Similar to Mg II k; Studies solar flares and energy;	Also studies how the solar flares heat up the chromosphere and how the energy is deposited. Combined with Mg II k provides measurement for density of the local plasma
Figure 3	Narrow Band 276 nm	Chromosphere, Blue wing of the Mg II valley	Focuses on solar flares, sunspots, and energy transfer; Useful for space weather understanding/ predictions	Effect of solar flares deeper in the Chromosphere. Combined with Mg II k provides information about long term solar activity variations.

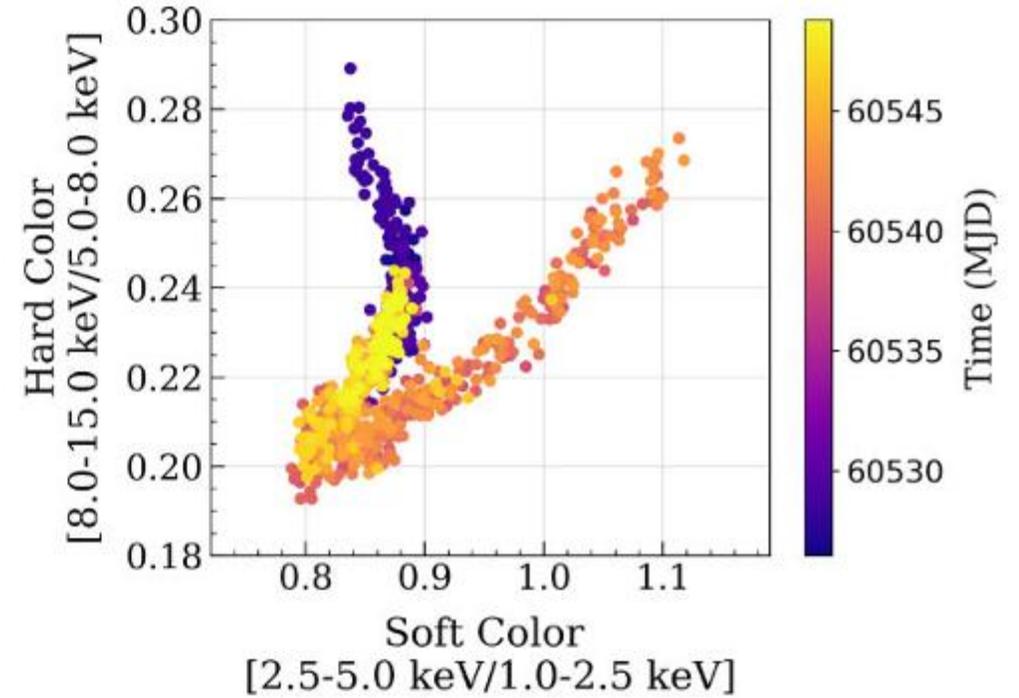
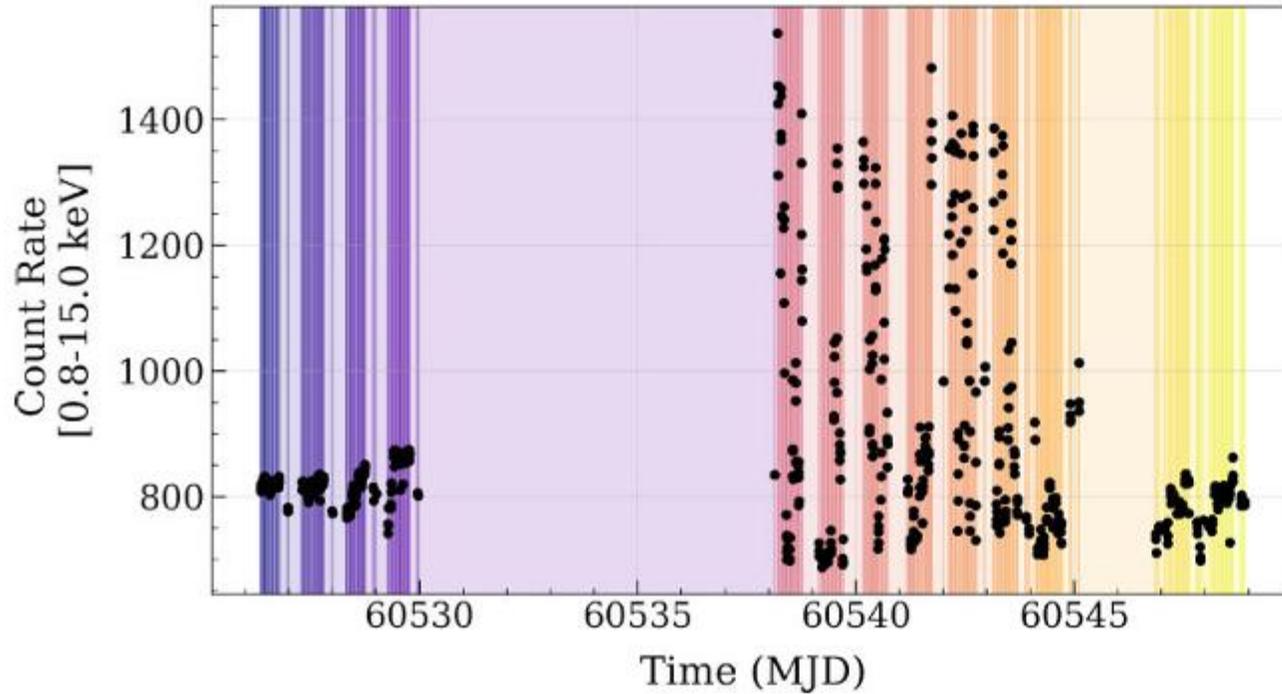
XPoSat: Opened Up for Proposal-based Usage by National Guest Users



Spectrum of Supernovae Remnant Cas A as seen by XSPECT/XPoSat

- **Detection of a Superburst:** The X-ray Spectroscopy and Timing (XSPECT) payload on XPoSat detected a thermonuclear Type-I X-ray burst immediately followed by a rare, long-duration 'superburst' from the neutron star binary system 4U 1608–52 in March 2025.
- **Characterization of Emission:** Initial studies of the superburst emission indicate a plausible Compton scattering process at play, which helps explain the high X-ray flux and its prolonged decay.
- **First-Light and Calibration:** The payloads successfully achieved "first light" soon after launch and underwent a performance verification phase.

XSPECT/XPoSat Observation of Neutron Star source Sco-X1



Light curve of Sco-X1 as observed by XSPECT/XPoSat showing flaring activities of the source.

Hardness Intensity Diagram plotted using XSPECT observations of Sco X-1

XSPECT observation provides high-quality soft X-ray pile-up free monitoring of the source Sco X-1 which has enabled detail study of the sources across its full Z-track evolution including the disc and Comptonization emission of the source. Ref: MNRAS 543, 3754–3767 (2025)