Proposed
Aditya-L1 Mission

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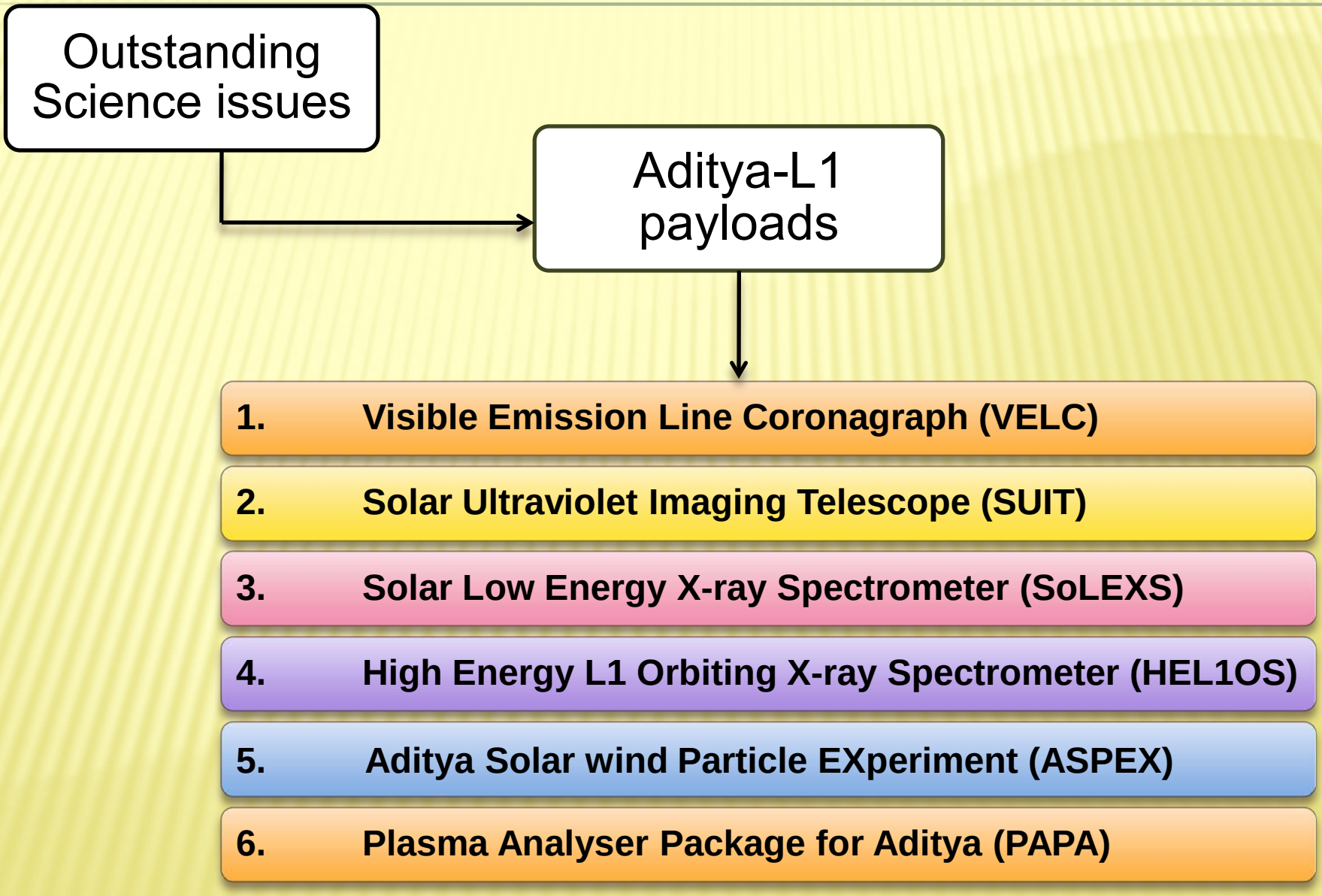
Introduction

- History of solar studies dates back to over hudred years within the country; Kodaikanal Observatory
- Large scientific community in several institutes involved in solar studies
- Requirement of space based solar observations strongly recommended in the vision document
- Proposed Aditya-L1 mission

Outstanding science issues related to Aditya-L1

- Studies to understand sources that heat the chromosphere, transition region and the solar corona, above the cooler photosphere
- Sequence of processes occurring on different layers of the Sun, especially leading to phenomena in the corona
- Origin and dynamics of solar wind, solar flares and Coronal Mass Ejections (CMEs) which has direct consequence on Space weather
- Solar spectral irradiance (UV) variations in the chromosphere
- Estimate of coronal magnetic field from space

Payloads selected for Aditya-L1



Visible Emission Line Coronagraph (VELC)

To study the diagnostic parameters of solar corona and dynamics and origin of CMEs (3 visible and 1 IR channels); magnetic field measurement of solar corona down to tens of Gauss .

VELC will address the following science aspects:

- Role of waves in coronal heating
- How are CMEs accelerated?
- What is the nature of the interaction between the CME plasma and the magnetic field that drives the eruption?
- What is the configuration of the magnetic field in the corona?
- How are the different components of the solar wind, slow and fast, accelerated?
- To what degree do coronal inhomogeneities affect the heating and acceleration processes?

Observational requirements

- Imaging the inner corona (1.05 – 3.0 sloar radius) at high spatial resolution and at high cadence (1 – 60 sec)
- Spectroscopic measurements (FOV: 1.05 – 1.5 solar radiusl) in two visible and one IR lines for understanding the heating, dynamics, temperature, density and structure of solar corona
- Spectro-polarimetry in near IR for topology and magnetic field measurements

The data will be complemented with ground based telescopes data to provide complete atmospheric coupling of the solar magnetic fields from the photosphere to the corona.

Lead institutions: Indian Institute of Astrophysics & ISRO

Solar Ultraviolet Imaging Telescope (SUIT)

To image the spatially resolved Solar Photosphere and Chromosphere in near Ultraviolet (200-400 nm) and measure solar irradiance variations.

SUIT will tackle the following issues…

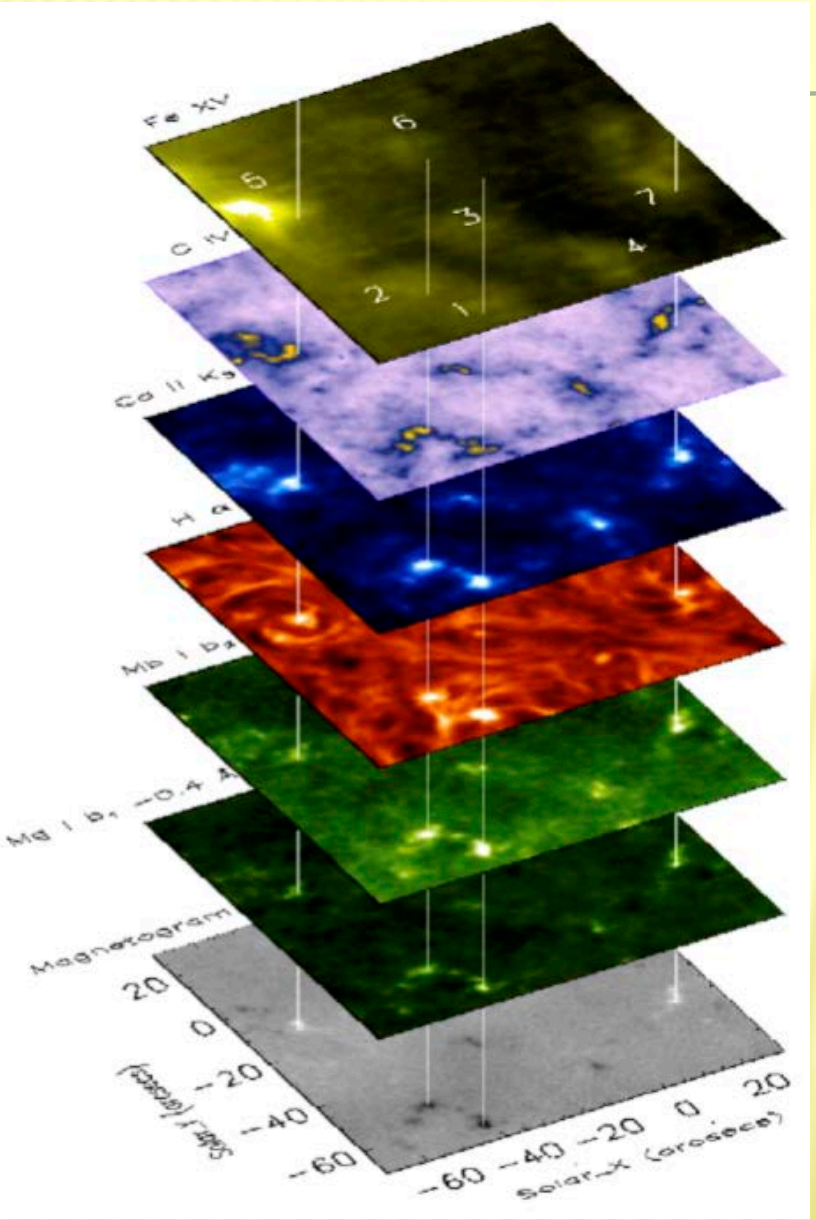
- Coupling and Dynamics of the Solar Atmosphere: What are the processes through which the energy is channelized and transferred from the photosphere to the chromosphere and then to the corona?
- Initiation of CMEs : What are the kinematics of erupting prominences during the early phase?
- Solar irradiance studies: Temporal variation and the spectral variation of the source regions.
- Prominence Studies: What are the mechanisms responsible for stability, dynamics and eruption of solar prominences?

Observational Requirements

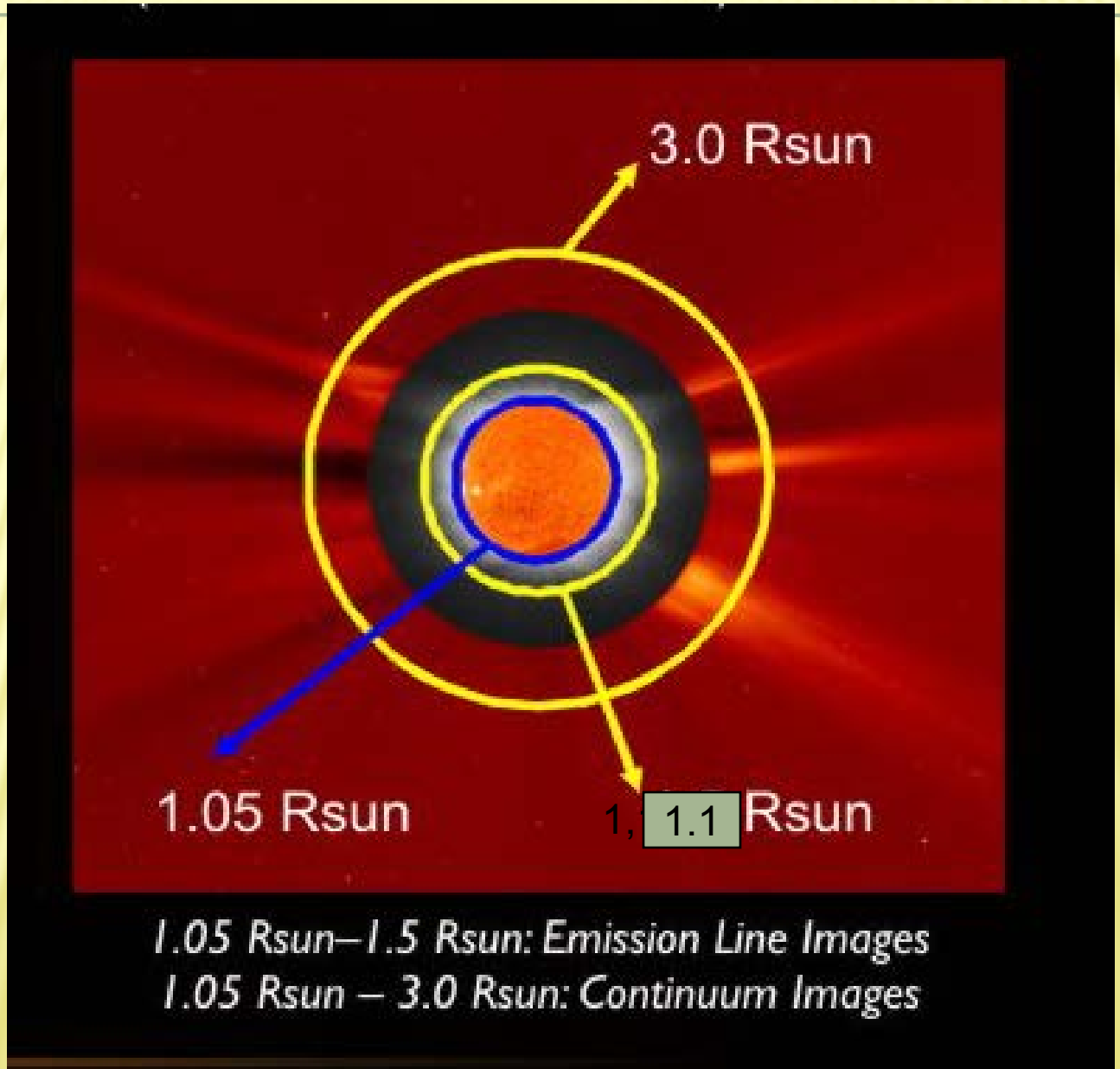
- Full disk observations in NUV (200 – 400 nm) in about 10 passbands using a filter-wheel mechanism.
- Combined medium and narrow-band filter imager with low stray light and high contrast to measure and monitor brightness contrast of solar magnetic features.
- Total FOV ~1.1 solar radii to overlap the FOV of VELC
- Observations with different settings of cadence, exposure time, angular resolution, regions of interest etc.

The data will be complemented with ground based telescopes data to provide magnetic field measurements. SUIT will provide continuous observations from photosphere, chromosphere and lower transition region.

Lead institutions: Inter-University Centre for Astronomy & Astrophysics & ISRO



- Stack the various filter images for the whole disc in conjunction with
- Ground based observations


3.0 Rsun
1.05 Rsun
1, 1.1 Rsun
1.05 Rsun–1.5 Rsun: Emission Line Images
1.05 Rsun – 3.0 Rsun: Continuum Images

Solar Low Energy X-ray Spectrometer (SoLEXS)

To monitor the X-ray flares (1 – 30 keV) for studying the heating mechanism of the solar corona

The payload will provide:

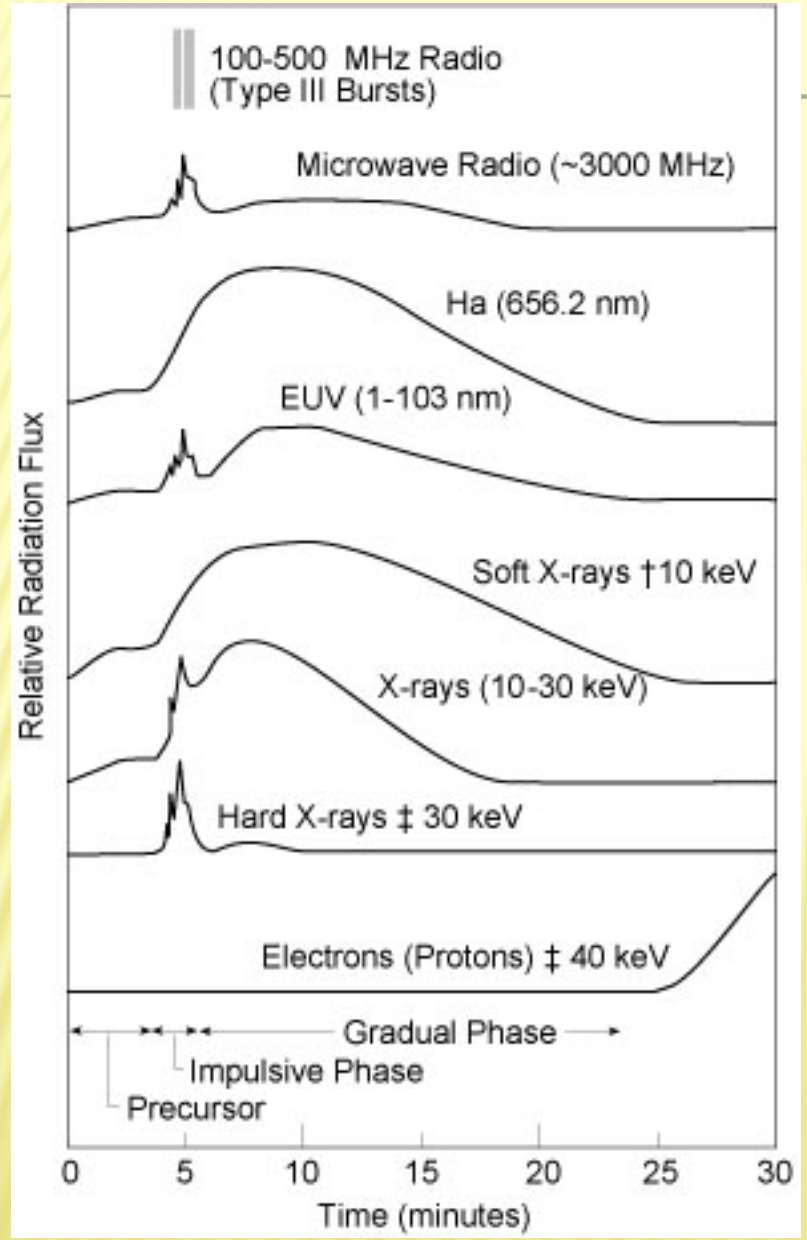
- Data for the study of DC heating mechanism
- The physical characteristics of solar flares ranging from the X-class to < A-class along with its association to CMEs
- Independent measure of coronal temperature (and Differential emission measure - DEM) as well as abundances of coronal plasma and
- Study of the CME-flare relation and its physical mechanism.

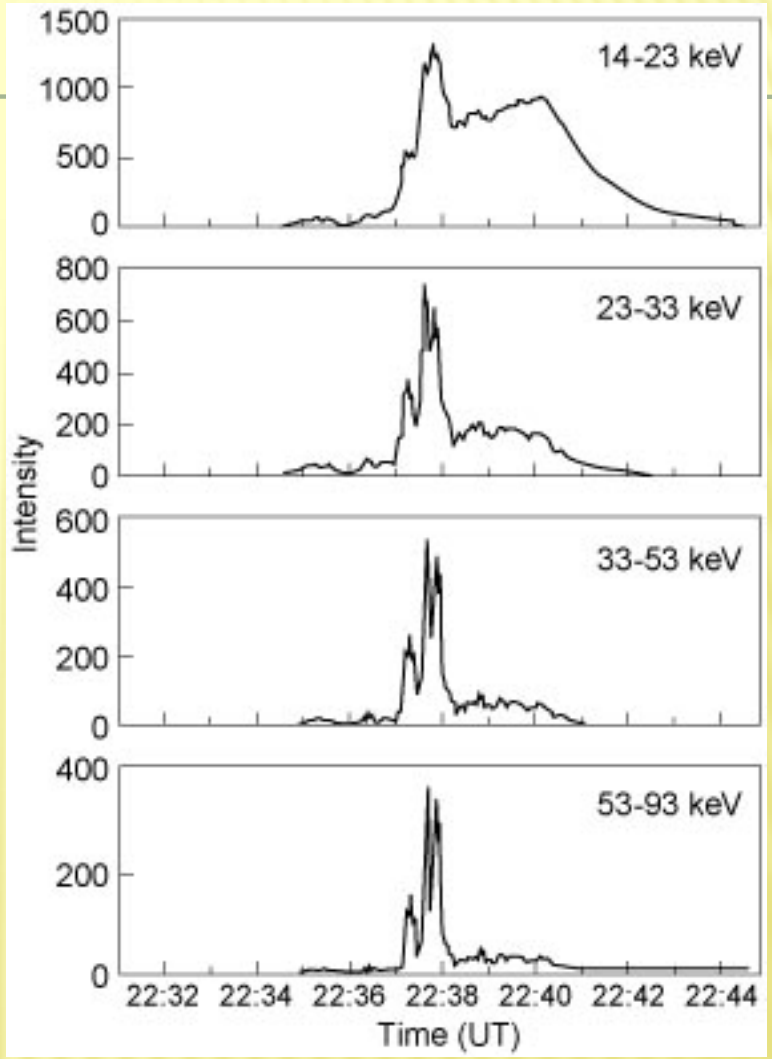
Observational Requirement

- Single pixel Silicon Drift Detector (SDD) to observe the complete solar disk in the 1 – 30 keV range.
- Large dynamic range and high spectral resolution (< 250 eV @ 5.9 keV) to measure the large variation in the flux
- FOV is 1 degree

SoLEXS along with VELC, SUIT and hard X-ray instrument will provide data to study the kinematics of solar flares and its energy contents.

Lead institution: Space Astronomy Grpoup ISRO





Courtsey: NASA

High Energy L1 Orbiting X-ray Spectrometer (HEL1OS)

HEL1OS is a spectrometer that views the Sun as a star and is designed to study hard X-ray (HXR) emission from 10 keV to 150 keV during the impulsive phase of solar flares.

The main science goals of HEL1OS are

- Study of explosive energy release, acceleration and transport of electrons using fast timing measurements and high resolution spectral studies.
- Study of the evolution of the low-energy non-thermal electron cut-off using high spectral resolution measurements.
- Provide fast continuous timing data for the study of sub-second variability during flares
- Understanding the science of eruptive events using complimentary multiwavelength observations.

Observational Requirement

- Two types of semiconductor detectors, CdZnTe and CdTe in the overall energy range of 10 – 150 keV will cover the overlap between thermal and non-thermal components of solar flare.
- Collimator FOV is 3 degree cone angle

HEL1OS data will be complemented by VELC, SoLEXS, SUIT and ground observations in the radio bands.

Lead institutions: Space Astronomy Grpoup ISRO

Aditya Solar wind Particle EXperiment (ASPEX)

To study the variation of solar wind properties as well as its distribution and spectral characteristics

ASPEX is aimed to

- Determine the variation of the spectrum of solar wind ions, supra-thermal ions and solar energetic particles during the solar cycle.
- Determine the variation of the thermal anisotropy of the constituents of solar wind (protons, α-particles and heavy ions) which is a measure of the efficacy of various acceleration and heating processes thought to occur in the interplanetary medium.
- Study of supra-thermal tail of solar wind particles and temporal variation
- Investigate energy dependence of proton/ alpha ratio and the temperature anisotropy of solar wind particles.

Instrument components:

- Solar Wind Ion Spectrometer (SWIS) to measure both the angular and energy distributions concurrently in addition to being able to separate protons, α-particles and heavy ions in 100 eV to 20 keV range.
- Supra Thermal Energetic Particle Spectrometer (STEPS) will sample the solar wind along four different directions and study the supra-thermal particles observed in the solar wind in 20 keV to 5 MeV range.

ASPEX will complement coronagraphic observations by determining the arrival time of interplanetary CMEs at L1.

Lead institutions: Physical Research Laboratory, ISRO

Plasma Analyser Package For Aditya (PAPA)

To understand the composition of solar wind and its energy distribution

Scientific objectives

- Continuous Measurement of the solar wind and interplanetary electron distribution functions in the energy range 0.01-3 keV to extract the interplanetary magnetic field structure and topology.
- Study of the composition of solar wind and thereby understanding about the origin of solar wind and particle acceleration mechanism.

Instrument components:

- Solar Wind Electron Energy Probe (SWEEP) to measure the solar wind and interplanetary electron distribution functions in the energy range 0.01-3 keV
- Solar Wind Ion Composition Analyser (SWICAR) to measure the kinetic temperatures and mean speeds of all major ion species in the mass range 1-30 amu.

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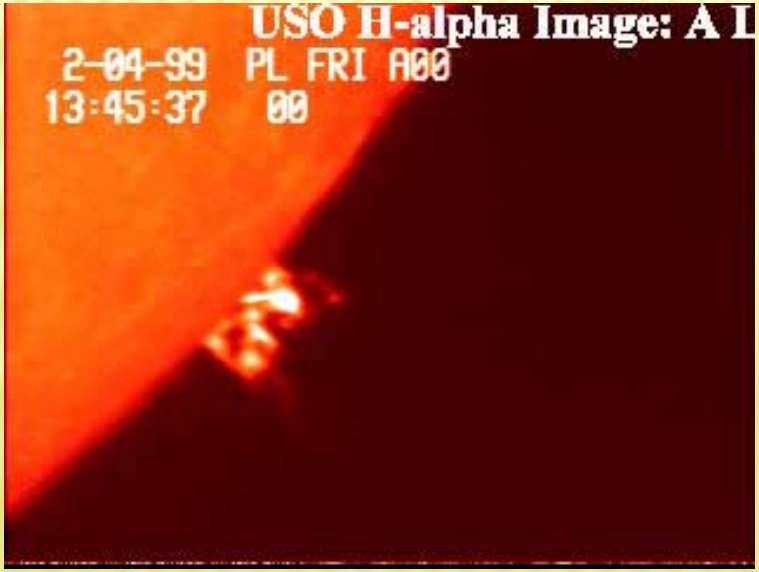
Lead institution: Space Physics Laboratory, Vikram Sarabhai Space Centre - ISRO

Aditya-L1 Mission

Proposed Indian solar observatory at L1

Mission objective: To design, realize and launch a satellite for solar studies to be placed in a halo orbit around the Lagrangian point 1 (L1) of the Sun-Earth system (1.5 million km from Earth; approximately 1/100th of AU).

Scientific objective: To study the solar dynamics in the chromosphere and corona with a suite of instruments including a coronagraph and a UV imager. The orbit around L1 provides continuous solar observations without any eclipse/ occultation and is an excellent outpost outside Earth's magnetic field to make in-situ measurements of incoming charge particles.



Initiation of mass ejection

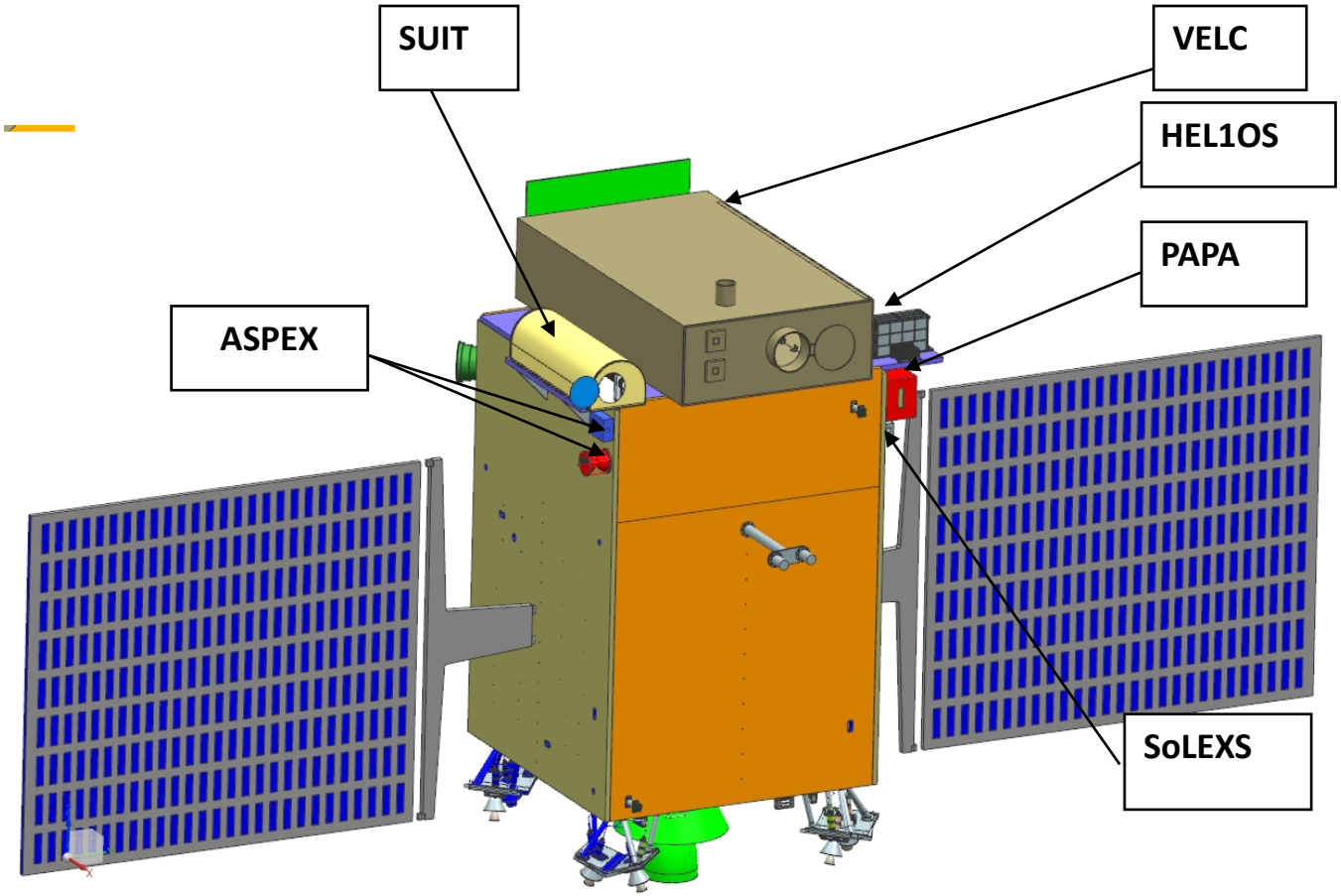
Launch : PSLV-XL

Target : 2018 – 2019

L1 Orbit insertion : ~ 100 days

Mission life : 5 years (nominal)

Schematic Layout of Aditya-L1 Payloads



THANK YOU...

Halo Orbit around L1 : Advantages

- Outside the Earth's atmosphere and its magnetosphere
  - + ideal to study solar wind and CMEs
- No occultation for the spacecraft's line of sight.
  - + Continuous observations of the Sun
- Stable orbit; less drift; mechanical and thermal disturbances are less
  - + Possible to do long integrations for measuring coronal magnetic field
- Station keeping maneuvers are less and hence long life of the spacecraft
  - + Able to observe the Sun during all phases of the solar cycle
- Placing a solar spacecraft at L1 will enhance the technical prowess of the Indian space programme.