ADITYA-L1 MISSION

THE FIRST OBSERVATORY-CLASS SPACE-BASED SOLAR MISSION FROM INDIA

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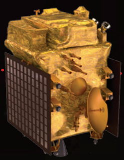
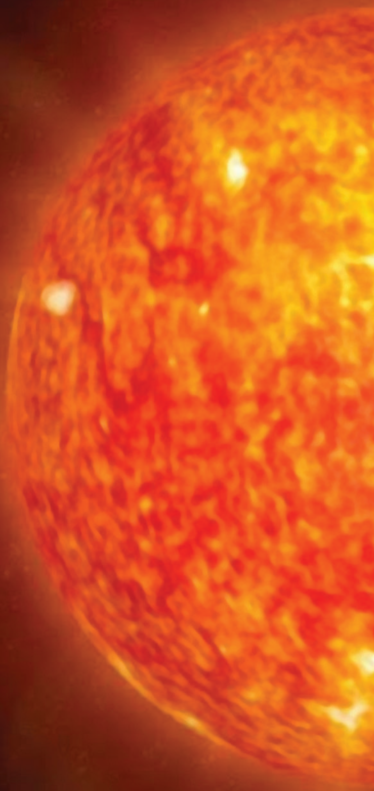


THE SUN

Our Sun is the nearest star and the largest object in the solar system. The estimated age of sun is about 4.5 billion years. It is a hot glowing ball of hydrogen and helium gases. The distance to the sun from the earth is about 150 million kilometres, and is the source of energy for our solar system. Without the solar energy the life on earth, as we know, can not exist. The gravity of the sun holds all the objects of the solar system together. At the central region of the sun, known as 'core', the temperature can reach as high as 15 million degree Celsius. At this temperature, a process called nuclear fusion takes place in the core which powers the sun. The visible surface of the sun known as photosphere is relatively cool and has temperature of about 5,500°C.



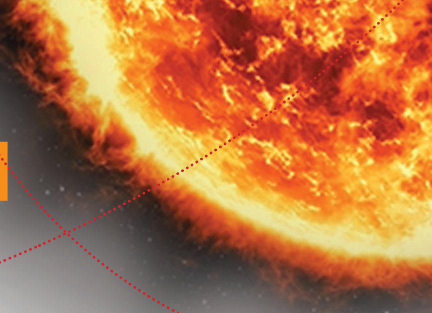
WHY STUDY SUN?

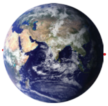
The sun is the nearest star and therefore can be studied in much more detail as compared to other stars. By studying the sun we can learn much more about stars in our Milky Way as well as about stars in various other galaxies.

The sun is a very dynamic star that extends much beyond what we see. It shows several eruptive phenomena and releases immense amount of energy in the solar system. If such explosive solar phenomena is directed towards the earth, it could cause various types of disturbances in the near earth space environment.

Various spacecraft and communication systems are prone to such disturbances and therefore an early warning of such events is important for taking corrective measures beforehand. In addition to these, if an astronaut is directly exposed to such explosive phenomena, he/she would be in danger.

The various thermal and magnetic phenomena on the sun are of extreme nature. Thus, the sun also provides a good natural laboratory to understand those phenomena which cannot be directly studied in the lab.

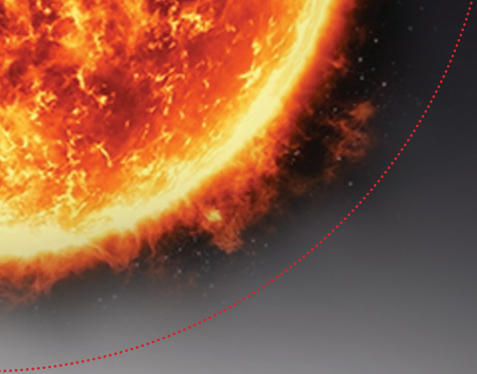




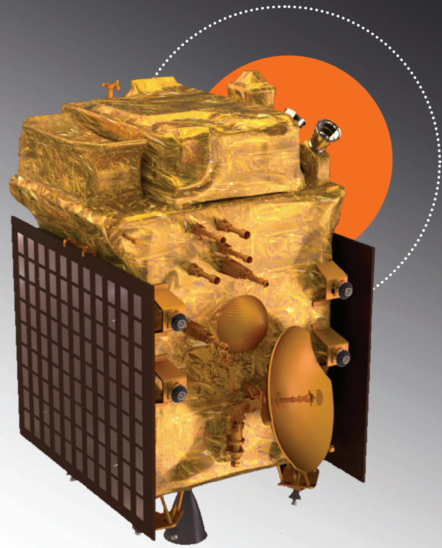
THE SPACE WEATHER

The sun constantly influences the Earth with radiation, heat and constant flow of particles and magnetic fields. The constant flow of particles from the sun is known as solar wind and are mostly composed of high energy protons. The solar wind fills nearly all the space of the known solar system. Along with the solar wind, the solar magnetic field also fill the solar system. The solar wind along with other explosive/ eruptive solar events like Coronal Mass Ejection (CME) affects the nature of space. During such events, the nature of magnetic field and charge particle environment near to the planet change. In case of the Earth, the interaction of Earth magnetic field with the field carried by CME can trigger a magnetic disturbance near the Earth. Such events can affect the functioning of space assets.

Space weather refers to changing environmental conditions in space in the vicinity of Earth and other planets. We use more and more technology in space, as understanding space weather is very important. Also, understanding near Earth space weather sheds light on the behaviour of space weather of other planets.

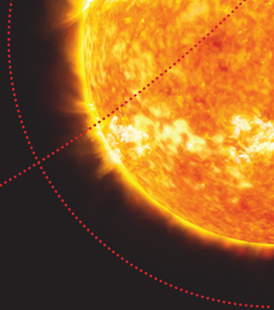


ABOUT ADITYA-L1



Aditya L1 is the first space based observatory class Indian solar mission to study the Sun. The spacecraft is planned to be placed in a halo orbit around the Lagrangian point 1 (L1) of the Sun-Earth system, which is about 1.5 million km from the Earth. A satellite placed in the halo orbit around the L1 point has the major advantage of continuously viewing the Sun without any occultation/ eclipse. This will provide a greater advantage of observing the solar activities continuously. The spacecraft carries seven payloads to observe the photosphere, chromosphere, and the outermost layers of the Sun (the corona) using electromagnetic and particle detectors. Using the special vantage point of L1, four payloads directly view the Sun and the remaining three payloads carry out in-situ studies of particles and fields at the Lagrange point L1.

The suit of Aditya L1 payloads are expected to provide most crucial information to understand the problems of coronal heating, Coronal Mass Ejection, pre-flare and flare activities, and their characteristics, dynamics of space weather, study of the propagation of particles, and fields in the interplanetary medium etc.



ADITYA-L1 MISSION

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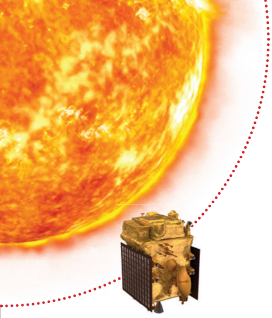
MAJOR SCIENCE OBJECTIVES

- Understanding the Coronal Heating and Solar Wind Acceleration.
- Understanding initiation of Coronal Mass Ejection (CME), flares and near-earth space weather.
- To understand coupling and dynamics of the solar atmosphere.
- To understand solar wind distribution and temperature anisotropy.

UNIQUENESS OF THE MISSION

- First time spatially resolved solar disk in the near UV band.
- CME dynamics close to the solar disk (~ from 1.05 solar radius) and thereby providing information in the acceleration regime of CME which is not observed consistently.
- On-board intelligence to detect CMEs and solar flares for optimised observations and data volume.
- Directional and energy anisotropy of solar wind using multi-direction observations.



ADITYA-L1 SCIENCE PAYLOADS

The Aditya-L1 mission carries a suit of seven scientific payloads to carry out systematic study of the Sun. The **Visible Emission Line Coronagraph** (VELC) studies the solar corona and dynamics of Coronal Mass Ejections. The **Solar Ultra-violet Imaging Telescope** (SUIT) payload images the Solar Photosphere and Chromosphere in near Ultra-violet (UV) and also measures the solar irradiance variations in near UV. The **Aditya Solar wind Particle EXperiment** (ASPEX) and **Plasma Analyser Package for Aditya** (PAPA) payloads study the solar wind and energetic ions, as well as their energy distribution. The **Solar Low Energy X-ray Spectrometer** (SoLEXS) and The **High Energy L1 Orbiting X-ray Spectrometer** (HEL1OS) studies the X-ray flares from the Sun over a wide X-ray energy range. The **Magnetometer** payload is capable of measuring interplanetary magnetic fields at the L1 point.

The science payloads of Aditya-L1 are being indigenously developed by different laboratories in the country. The VELC instrument is being developed at the Indian Institute of Astrophysics, Bangalore; SUIT instrument at Inter University Centre for Astronomy & Astrophysics , Pune; ASPEX instrument at Physical Research Laboratory, Ahmedabad; PAPA payload at Space Physics Laboratory, Vikram Sarabhai Space Centre, Thiruvananthapuram; SoLEXS and HEL1OS payloads at U R Rao Satellite Centre, Bangalore, and the Magnetometer payload at the Laboratory for Electro Optics Systems, Bangalore. All the payloads are being developed with the close collaboration of various centres of ISRO.

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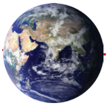


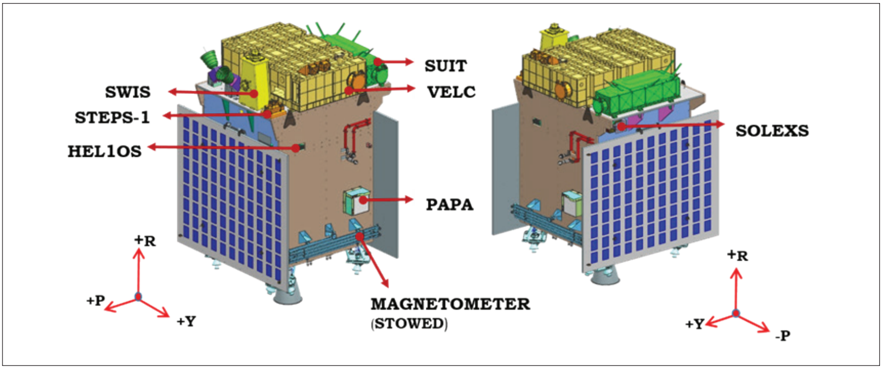


Fig1: Locations of Aditya-L1 payloads on the spacecraft. R, P and Y indicate the Raw, Pitch and Roll axis of the spacecraft. ASPEX Payload Consists of SWIS & STEPS.

LAGRANGE POINTS

For a two body gravitational system, the Lagrange Points are the postions in space where a small object tends to stay, if put there. These points in space for a two body systems such as Sun and Earth can be used by spacecraft to remain at these positions with reduced fuel consumption.

Technically at Lagrange point, the gravitational pull of the two large bodies equals the necessary centripetal force required for a small object to move with them. For two body gravitational systems, there are total five Lagrange points denoted as L1, L2, L3, L4 and L5. The Lagrange points for Sun-Earth system are shown in the figure. The Lagrange point L1 lies between Sun-Earth line. The distance of L1 from Earth is approximately 1% of the Earth-Sun distance.

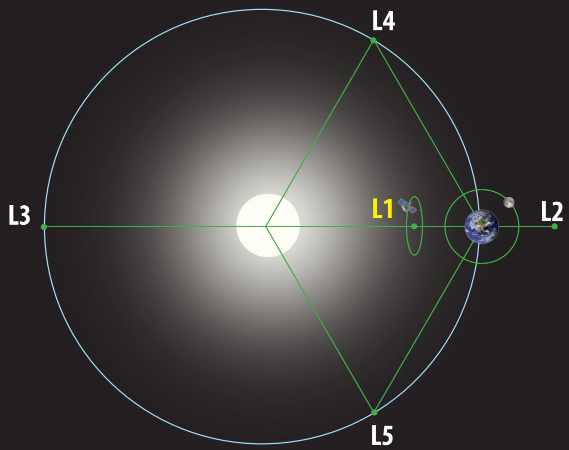


Fig 2 : Illustration of Lagrange points of the Sun-Earth system

ADITYA-L1 TRAJECTORY TO L1

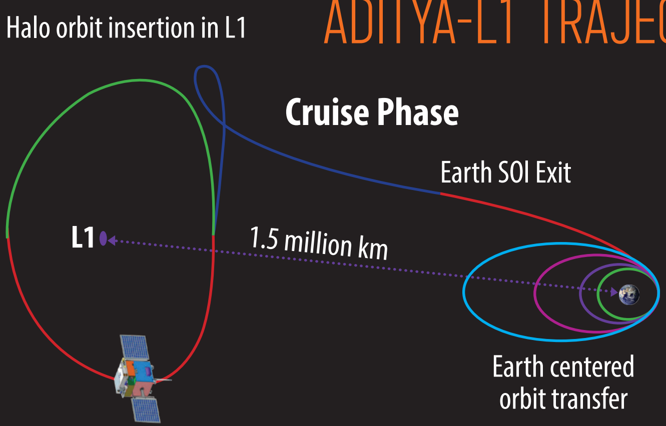
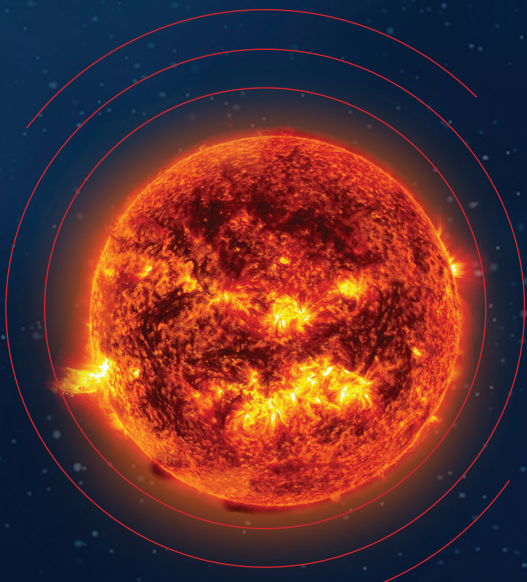


Fig 3: Aditya-L1 trajectory from Earth to L1.

The Aditya-L1 mission will be launched by ISRO PSLV rocket from Sathish Dhawan Space Centre SHAR (SDSC SHAR), Sriharikota. Initially the spacecraft will be placed in a low earth orbit. Subsequently, the orbit will be made more elliptical and later the spacecraft will be launched towards the Lagrange point L1 by using on-board propulsion. As the spacecraft travels towards L1, it will exit the earths' gravitational Sphere of Influence (SOI). After exit from SOI, the cruise phase will start and subsequently the spacecraft will be injected into a large halo orbit around L1. The total travel time from launch to L1 would take about four months for Aditya-L1. The trajectory of Aditya-L1 mission is shown in the figure above.

WHY STUDY SUN FROM SPACE?

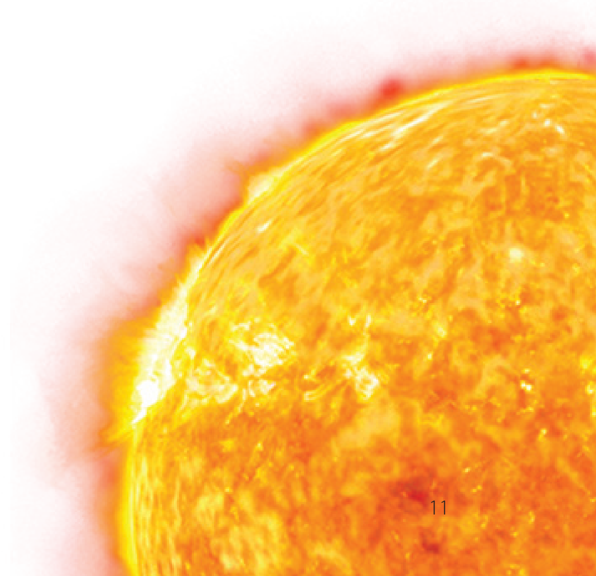
The sun emits radiation/light in nearly all wavelengths along with various energetic particles and magnetic field. The atmosphere of the Earth as well as its magnetic field acts as a protective shield and blocks a number of harmful wavelength radiations including particles and fields. As various radiations don't reach the surface of the Earth, the instruments from the Earth will not be able to detect such radiation and solar studies based on these radiations could not be carried out. However, such studies can be carried out by making observations from outside the Earth atmosphere i.e., from space. Similarly, to understand how the solar wind particles and magnetic field from the Sun travel through the interplanetary space, measurements are to be performed from a point which is far away from the influence of the Earth's magnetic field.

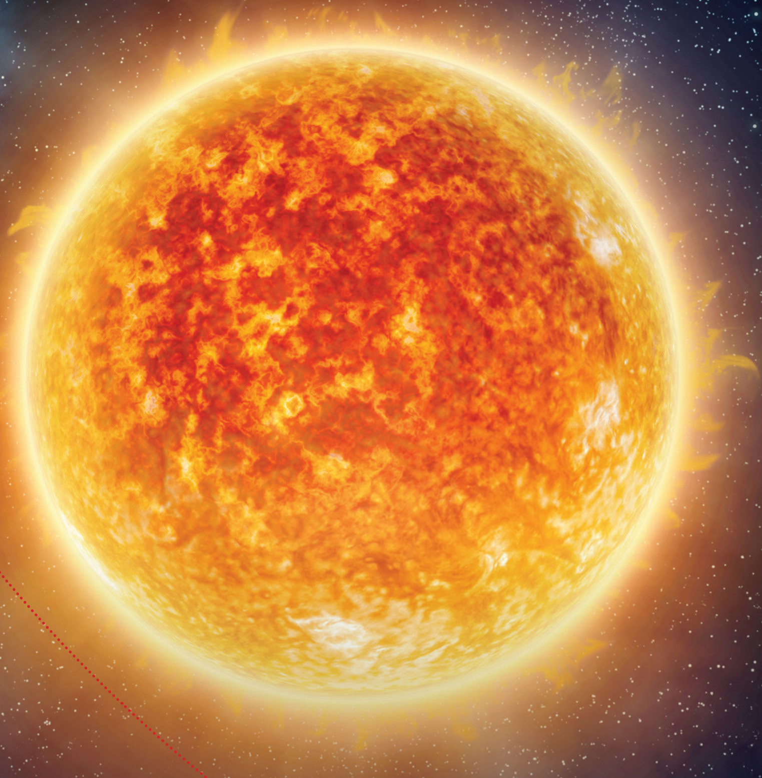


IS ADITYA-L1 A COMPLETE MISSION TO STUDY THE SUN?

The obvious answer is a 'NO' which is not only true for Aditya-L1 but in general for any space mission. The reason is that due to the limited mass, power and volume of the spacecraft that carries the scientific payloads in space, only a limited set of instruments with limited capacity can be sent on-board the spacecraft. In case of Aditya-L1, all the measurements will be made from the Lagrange point L1. As an example, the various phenomena of the sun are multi-directional and therefore the directional distribution of energy of explosive/eruptive phenomena will not be possible to study with Aditya-L1 alone.

Another Lagrange point known as L5 is a good vantage point for studying the Earth directed CME events and assessing the space weather. Also, the polar regions of the sun are not well studied due to technological challenges of achieving spacecraft orbits for such studies. The sun polar dynamics and magnetic fields are believed to play important role in deriving the solar cycles. Further, the polarisation measurements of solar radiations at different wavelengths are required to understand the various processes occurring in and around the sun.





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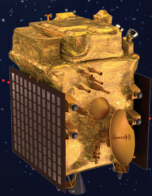

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