

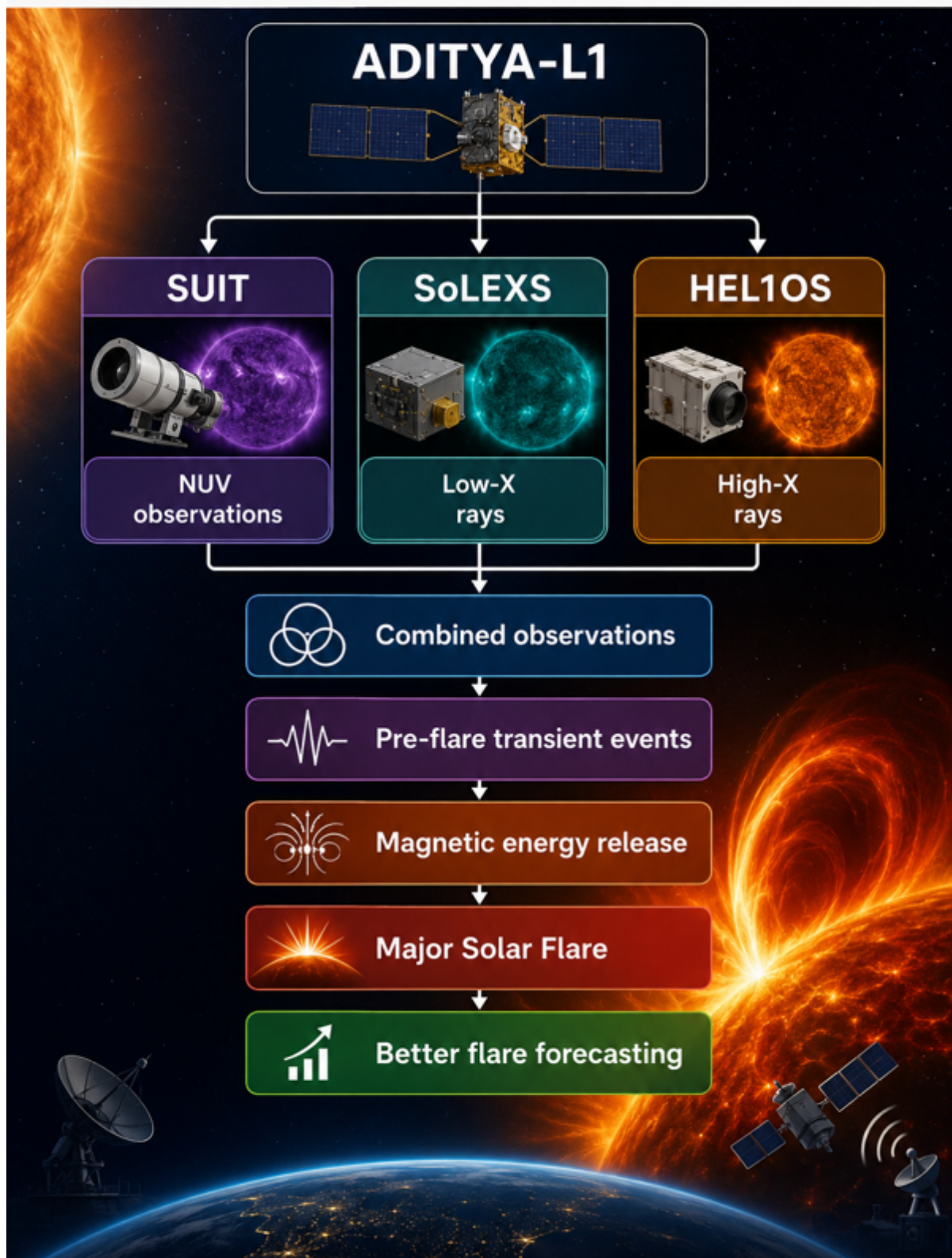
Aditya-L1 Study : Early Warning Signs of Solar Flares

Prelims: Current events of national and international importance | Space

Why in News?

Recently, India's Aditya-L1 mission has detected small, short-lived brightening in the Sun's atmosphere hours before major solar flares, clustered around the future flare site.

- **Study conducted by** - Manipal Centre for Natural Sciences, Manipal Academy of Higher Education (MAHE), ISRO & Department of Space.
- **Key findings**
- **Pre-flare transient events** - These are characterized by small, short-lived **brightenings** in the solar atmosphere.
 - These events typically appear several hours prior to a major solar flare.
 - They are primarily detected using the Mg II h filter of the Solar Ultraviolet Imaging Telescope (SUIT), which observes the chromospheric layer.
- **Spatial clustering** - These transients **cluster around the exact location** where the major flare later occurs.
- **Energy signature** - Some transients show **corresponding X-ray signatures**, indicating **magnetic energy release** even at this small scale.
- **Interpretation** - Repeated small-scale **energy releases** progressively destabilize **the magnetic field** within an active region, ultimately triggering a major solar flare.
- **Instruments** - **Simultaneous use of UV (SUIT) and X-ray (SoLEXS, HEL10S)** data.
- **SUIT (Solar Ultraviolet Imaging Telescope)** - It observes the Sun using 11 near-ultraviolet (NUV) filters.
 - It probes solar atmospheric layers ranging from the upper photosphere to the chromosphere.
 - Because near-ultraviolet (NUV) radiation is largely blocked by Earth's atmosphere, space-based observation is essential.
- **SoLEXS & HEL10S (X-ray spectrometers)** - These instruments measure X-ray emission resulting from energetic processes in the solar corona.
 - They facilitate the correlation of lower atmospheric activity in the chromosphere with coronal energy release during flare development.
- **L1 orbit advantage** - Continuous monitoring enables tracking of pre-flare evolution without data gaps.



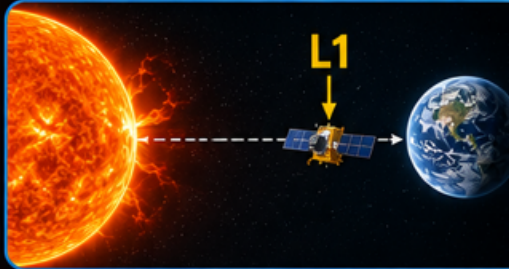
- **Advantages**

- **Early Warning Indicators** - Transient brightenings occurring hours before flares indicate potential pre-flare activity.

- **Better Solar-Flare Forecasting** - Verified transient events may serve as reliable indicators of impending flares.
- **Understanding Flare Formation** - Minor energy releases gradually destabilise active regions prior to major flares.
- **Space Weather Insight** - Accurate flare prediction enhances preparedness for impacts on Earth and in near-Earth space.
- **Satellite Protection** - Advance forecasts support precautionary measures to protect spacecraft.
- **Communication & Navigation Safety** - Improved prediction reduces disruptions to radio, GPS, and satellite services.
- **Astronaut Safety** - Early warnings help mitigate radiation hazards for astronauts and space missions.



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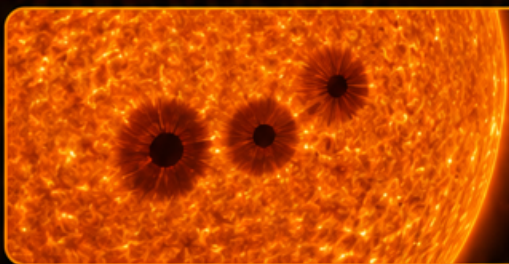
LAGRANGE POINT L1 –

The gravitational equilibrium point between the Sun and Earth, making it ideal for continuous solar observation.



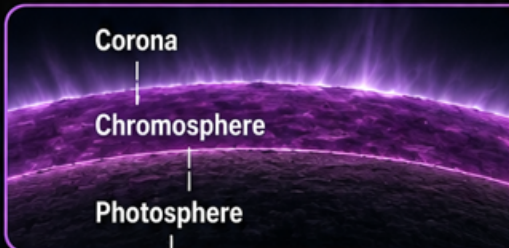
SOLAR FLARE –

A sudden release of magnetic energy in the Sun's atmosphere that emits intense electromagnetic radiation across the spectrum.



ACTIVE REGION –

An area on the Sun characterized by strong, complex magnetic fields, frequently associated with sunspots and flares.



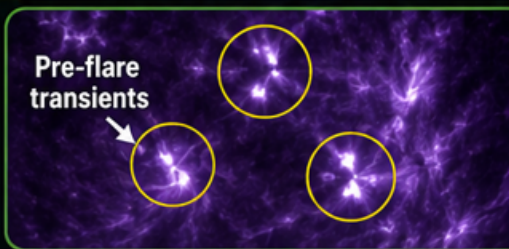
CHROMOSPHERE –

The layer of the solar atmosphere located above the photosphere, investigated in this context using the Mg II h ultraviolet line.



CORONA –

The outermost layer of the solar atmosphere, which serves as the primary source of X-ray emission during solar flares.



PRE-FLARE TRANSIENTS –

Brief, localized brightenings that occur before a major solar flare, indicating the early release of magnetic energy.

Reference

[ISRO | Sun's Early Warning Signs Before Solar Flares](#)



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