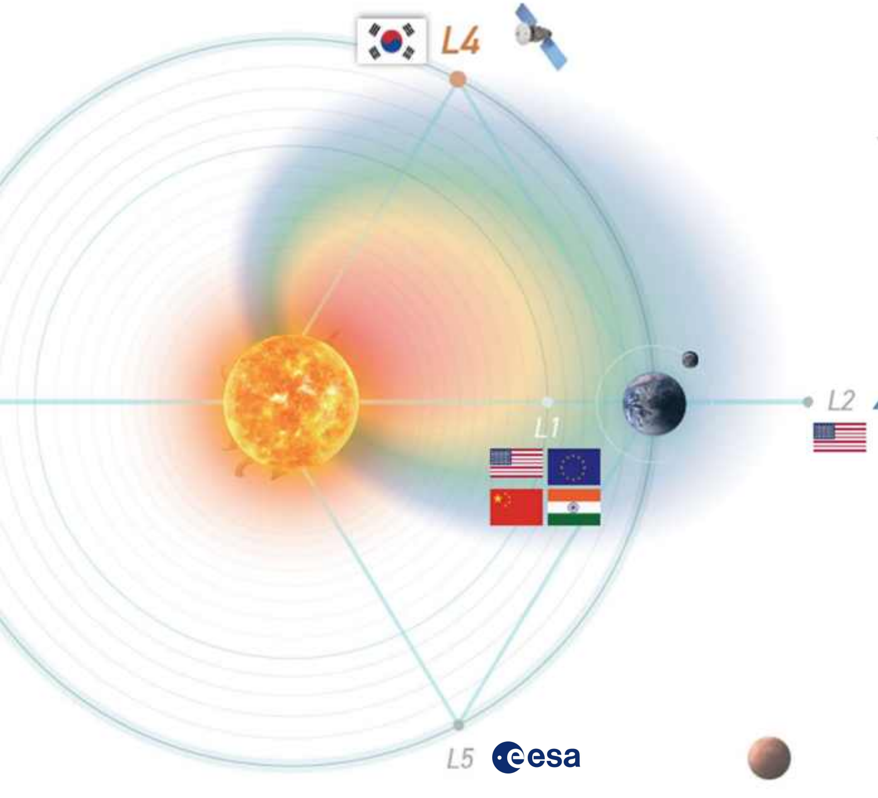
# Opening New Horizons with the Korea-led L4 Mission: March 2025 Progress Report



KASI 한국천문연구원
Korea Astronomy & Space Science Institute

**Kyung-Suk Cho**
**& KASI L4 Team**

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# Mission Overview

# KASA-NASA L4 Agreement

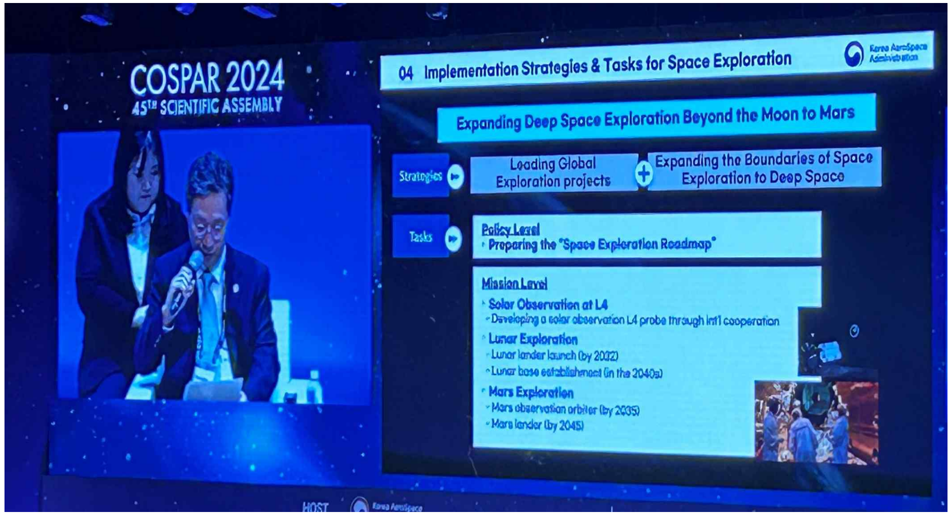
동아사이언스

정책

우주청, NASA와 L4 탐사 미션 개념 공동 연구 나선다

2024.09.22 14:00

윤영빈 우주항공청 청장(왼쪽)이 빌 넬슨 미국항공우주국(NASA) 청장과 협약식을 체결하고 기념촬영을 하고 있다. 우주항공청 제공



04 Implementation Strategies & Tasks for Space Exploration

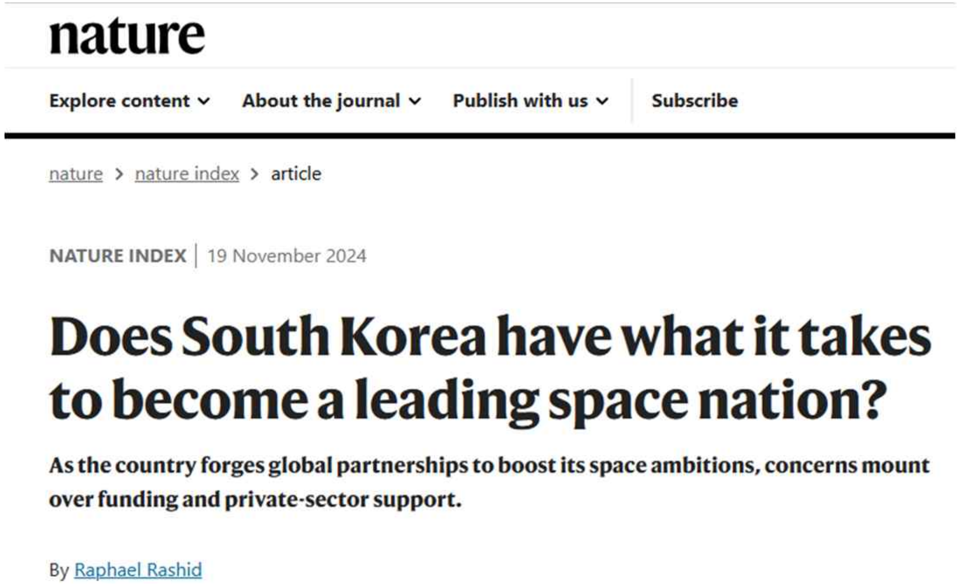
Expanding Deep Space Exploration Beyond the Moon to Mars

Strategies: Leading Global Exploration projects + Expanding the Boundaries of Space Exploration to Deep Space

Tasks:

Policy Level
- Preparing the "Space Exploration Roadmap"

Mission Level
- Solar Observation at L4
  - Developing a solar observation L4 probe through int'l cooperation
- Lunar Exploration
  - Lunar lander launch (by 2032)
  - Lunar base establishment (in the 2040s)
- Mars Exploration
  - Mars observation orbiter (by 2035)
  - Mars lander (by 2045)



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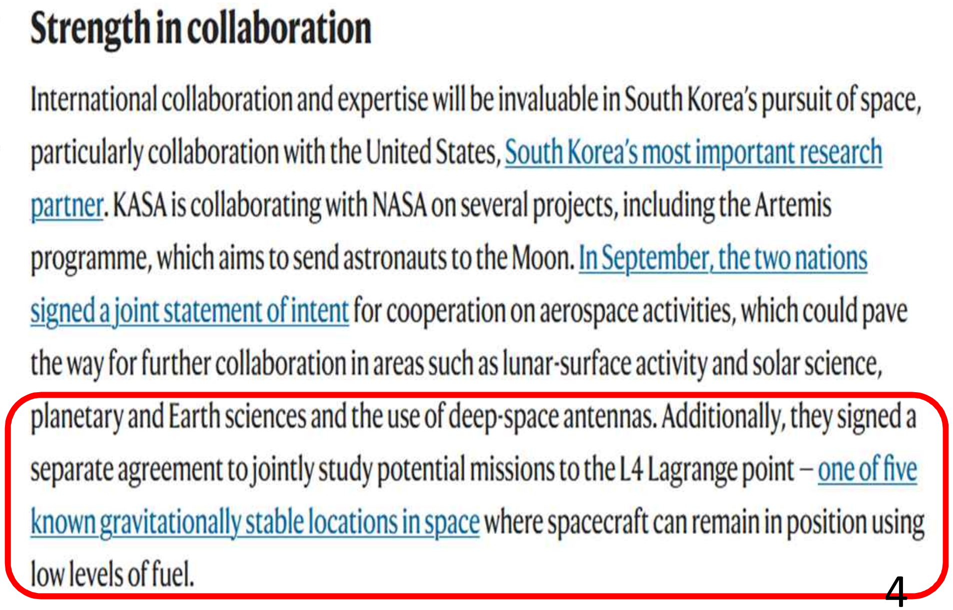
NATURE INDEX | 19 November 2024

## Does South Korea have what it takes to become a leading space nation?

**As the country forges global partnerships to boost its space ambitions, concerns mount over funding and private-sector support.**

By Raphael Rashid



### Strength in collaboration

International collaboration and expertise will be invaluable in South Korea's pursuit of space, particularly collaboration with the United States, South Korea's most important research partner. KASA is collaborating with NASA on several projects, including the Artemis programme, which aims to send astronauts to the Moon. In September, the two nations signed a joint statement of intent for cooperation on aerospace activities, which could pave the way for further collaboration in areas such as lunar-surface activity and solar science, planetary and Earth sciences and the use of deep-space antennas. Additionally, they signed a separate agreement to jointly study potential missions to the L4 Lagrange point – one of five known gravitationally stable locations in space where spacecraft can remain in position using low levels of fuel.

# KASA Policy Direction

**Space Launch Vehicle**

Enter the global market

**Satellite**

Provide science and public service

**Space Exploration**

Explore the Moon, Mars and beyond

**Aeronautics**

Promote industry

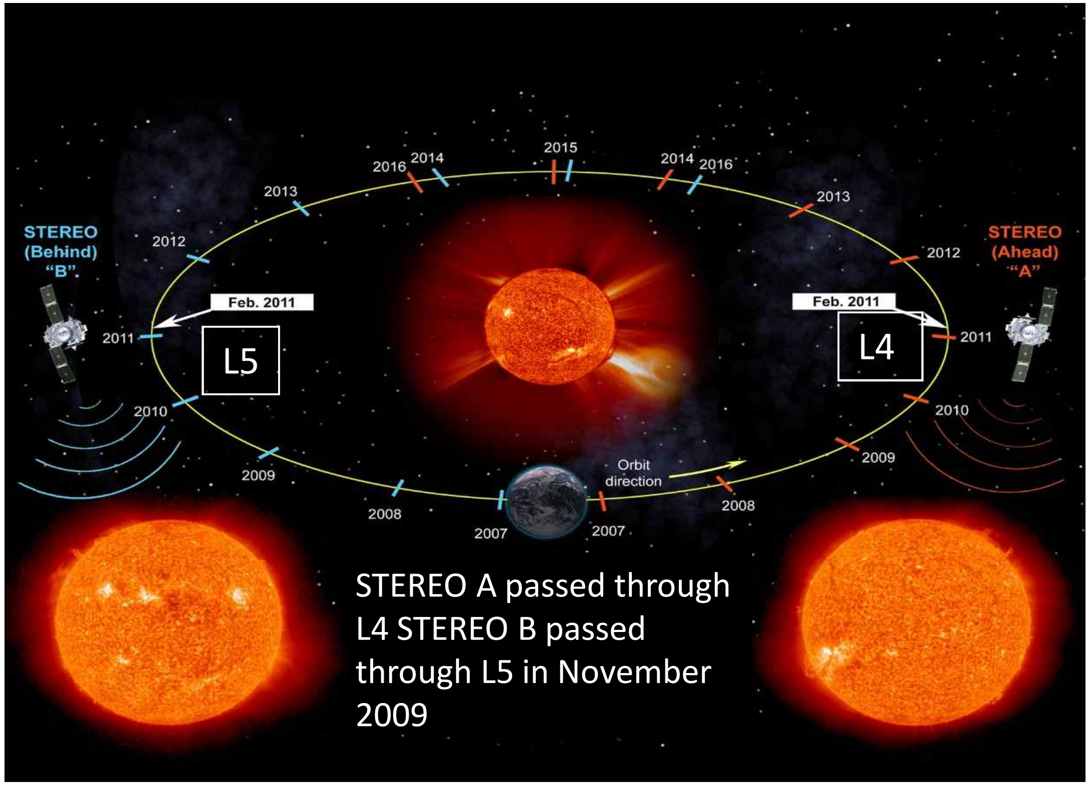
According to the policy direction announced on Feb 14th 2025 by the 1st National Space Committee meeting, **the L4 Mission is one of the highest priorities** in KASA's space exploration initiatives.

KASI is currently conducting a feasibility study of 'Korea-led L4 mission for Heliospheric Observation through international collaboration from 2023 to 2025.

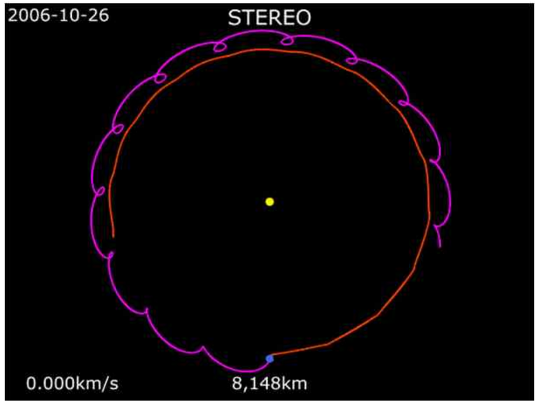
# Motivation: Lesson Learned from STEREO

**→ Combined STEREO and SOHO observations determined that many particle events at Earth originate from the region behind the solar limb, best viewed from L4.**

- Measuring magnetic properties of CMEs and solar wind structure is central to future Lagrange missions
- Would have done a lot more if it had magnetographs

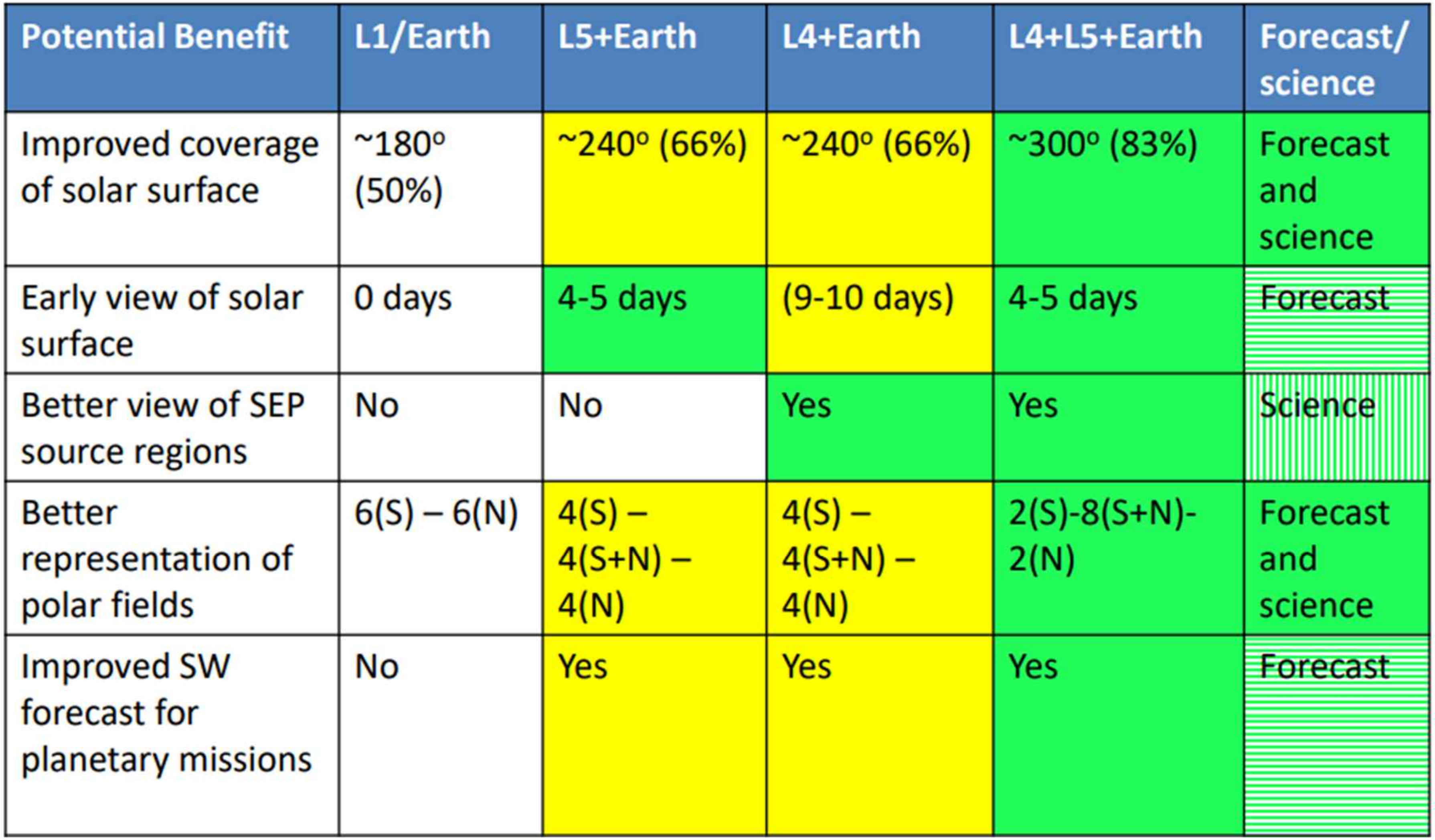


STEREO A passed through L4 STEREO B passed through L5 in November 2009



Demonstrated the utility of observing the sun from vantage points off of the sun-earth line and the utility of the heliospheric imager concept from those vantage points.

# Benefits: L5 vs. L5+L4

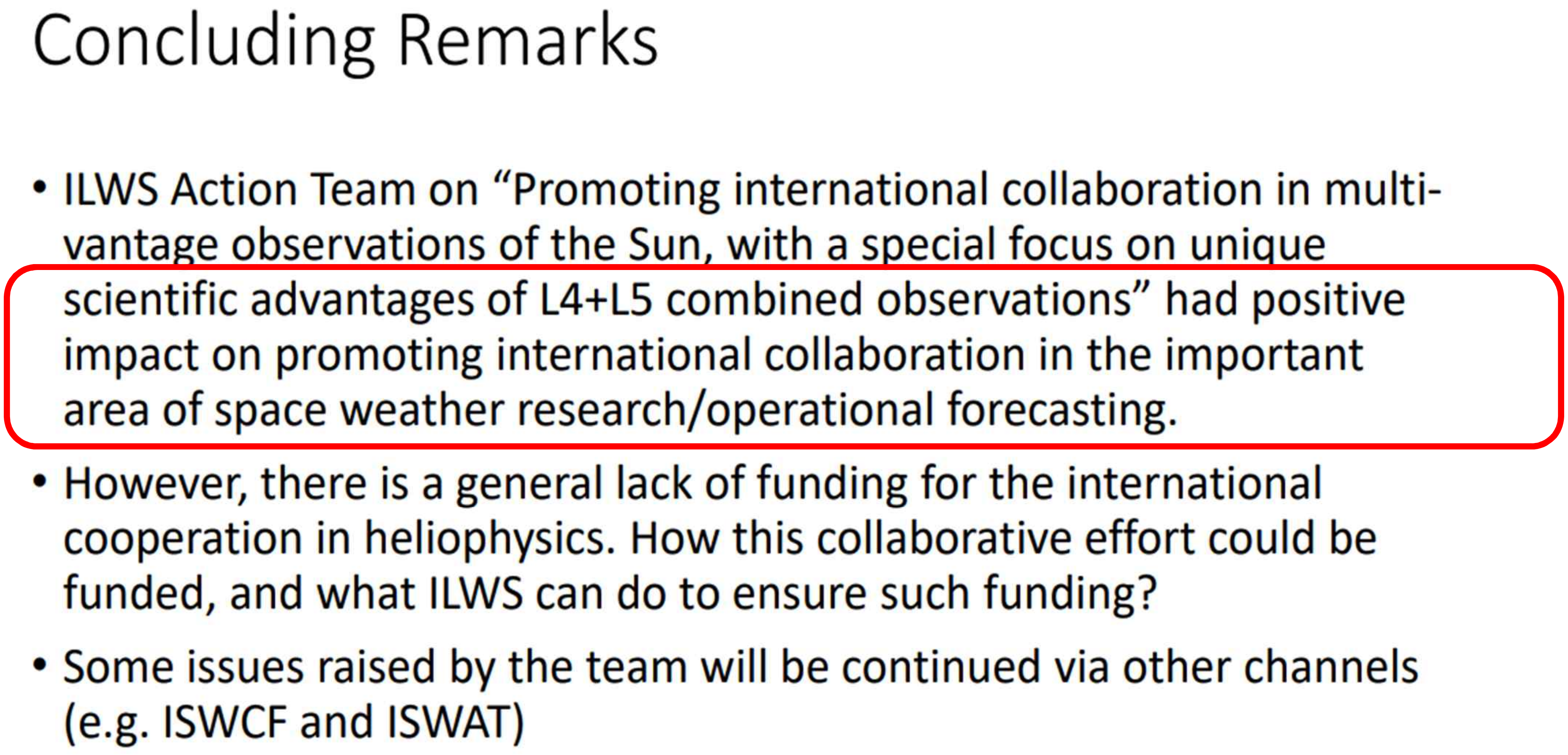


| Potential Benefit | L1/Earth | L5+Earth | L4+Earth | L4+L5+Earth | Forecast/ science |
|---|---|---|---|---|---|
| Improved coverage of solar surface | ~180º (50%) | ~240º (66%) | ~240º (66%) | ~300º (83%) | Forecast and science |
| Early view of solar surface | 0 days | 4-5 days | (9-10 days) | 4-5 days | Forecast |
| Better view of SEP source regions | No | No | Yes | Yes | Science |
| Better representation of polar fields | 6(S) – 6(N) | 4(S) – 4(S+N) – 4(N) | 4(S) – 4(S+N) – 4(N) | 2(S)-8(S+N)-2(N) | Forecast and science |
| Improved SW forecast for planetary missions | No | Yes | Yes | Yes | Forecast |

Credit: COSPAR ILWS Report (2018)

# Motivation: COSPAR ILWS Action Team Report (2024)

Action Team on “**Promoting international collaboration in multi-vantage observations of the Sun, with a special focus on unique scientific advantages of L4+L5 combined observations.**”



## Concluding Remarks

- ILWS Action Team on “Promoting international collaboration in multi-vantage observations of the Sun, with a special focus on unique scientific advantages of L4+L5 combined observations” had positive impact on promoting international collaboration in the important area of space weather research/operational forecasting.
- However, there is a general lack of funding for the international cooperation in heliophysics. How this collaborative effort could be funded, and what ILWS can do to ensure such funding?
- Some issues raised by the team will be continued via other channels (e.g. ISWCF and ISWAT)

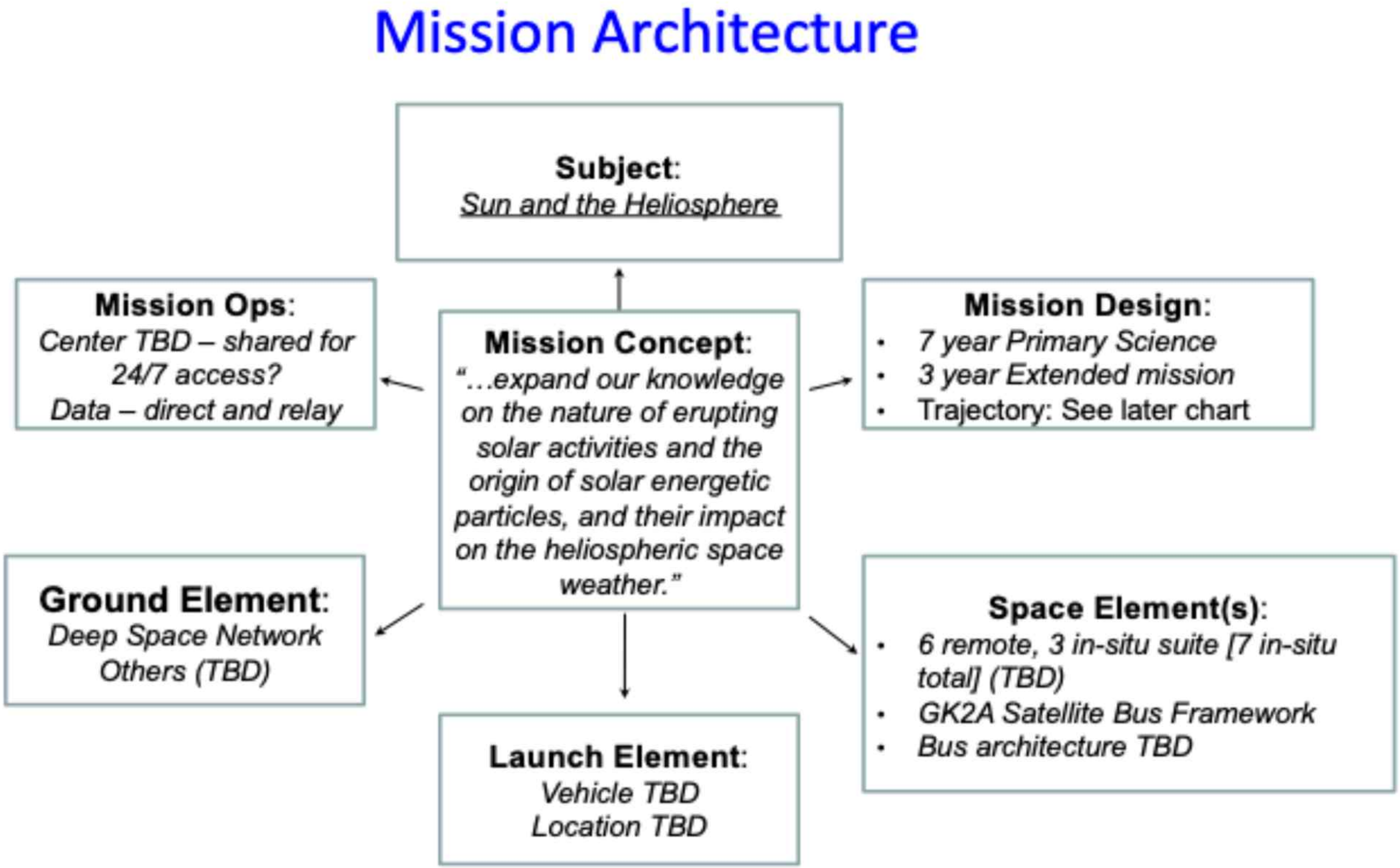
# L4 Feasibility Study Roadmap

- Goal: Prepare Proposal to be submitted to Korean Space Agency

- Purpose:  Develop analysis, plans, and strategy to receive a approval to proceed with the L4 mission

: Discuss at NASA-KASI Working Group meetings regarding L4 science and payload collaboration
: Review technical capability of domestic payloads, satellites, launch vehicles, etc
: Propose unique Korean payloads for L4.
: Secure international partners or develop strategies to develop domestically
: Select which elements of L4 should be developed domestically
(e.g. Payloads + Satellites + Launch vehicles)

# L4 Mission Architecture



## Mission Architecture

**Subject**:
<u>*Sun and the Heliosphere*</u>

**Mission Ops**:
*Center TBD – shared for 24/7 access?*
*Data – direct and relay*

**Mission Concept**:
*"…expand our knowledge on the nature of erupting solar activities and the origin of solar energetic particles, and their impact on the heliospheric space weather."*

**Mission Design**:
- *7 year Primary Science*
- *3 year Extended mission*
- Trajectory: See later chart

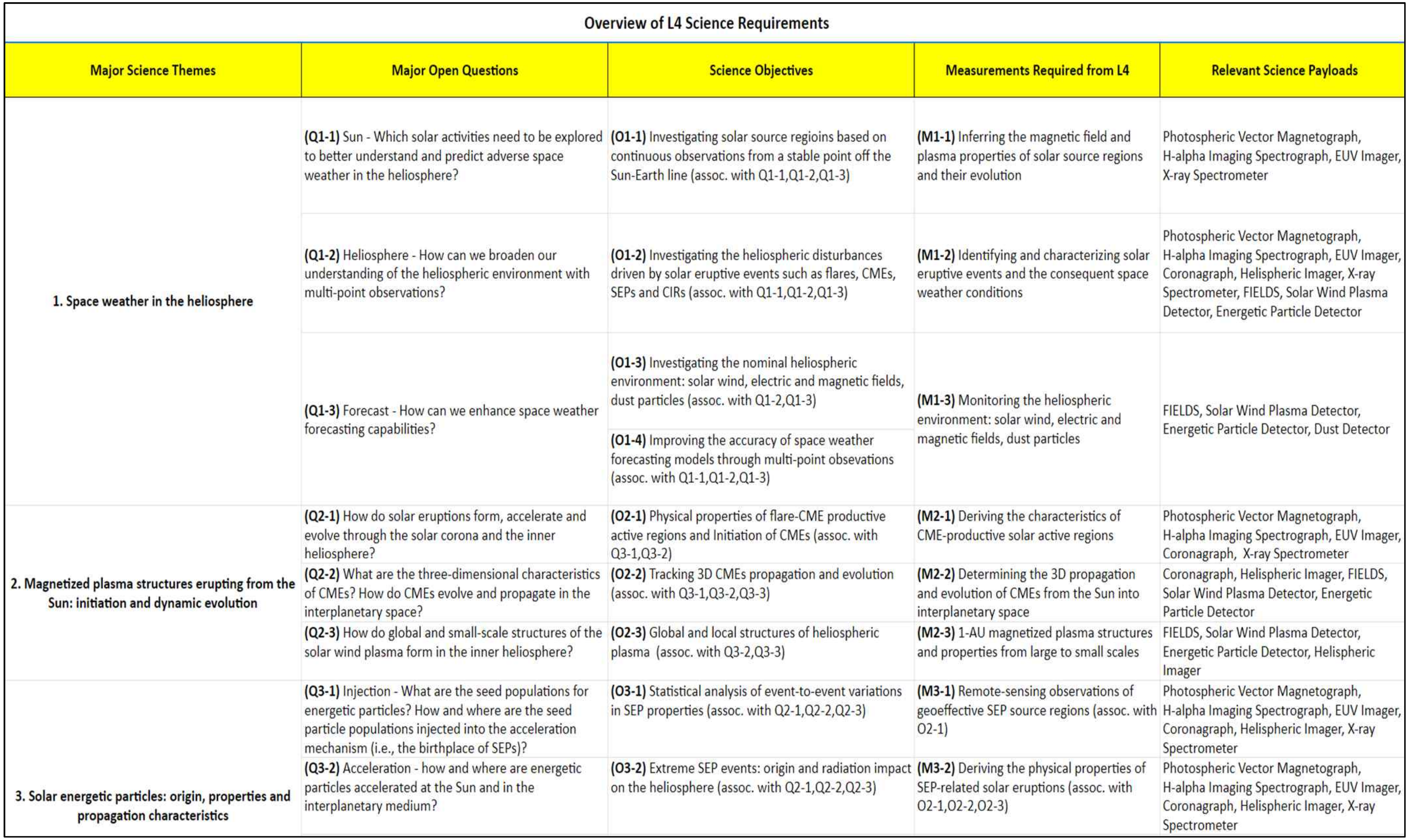
**Ground Element**:
*Deep Space Network*
*Others (TBD)*

**Space Element(s)**:
- *6 remote, 3 in-situ suite [7 in-situ total] (TBD)*
- *GK2A Satellite Bus Framework*
- *Bus architecture TBD*

**Launch Element**:
*Vehicle TBD*
*Location TBD*

# L4 Science Requirement

## (L4 mission's science requirements document)



**Overview of L4 Science Requirements**

| Major Science Themes | Major Open Questions | Science Objectives | Measurements Required from L4 | Relevant Science Payloads |
|---|---|---|---|---|
| 1. Space weather in the heliosphere | **(Q1-1)** Sun - Which solar activities need to be explored to better understand and predict adverse space weather in the heliosphere? | **(O1-1)** Investigating solar source regioins based on continuous observations from a stable point off the Sun-Earth line (assoc. with Q1-1,Q1-2,Q1-3) | **(M1-1)** Inferring the magnetic field and plasma properties of solar source regions and their evolution | Photospheric Vector Magnetograph, H-alpha Imaging Spectrograph, EUV Imager, X-ray Spectrometer |
| | **(Q1-2)** Heliosphere - How can we broaden our understanding of the heliospheric environment with multi-point observations? | **(O1-2)** Investigating the heliospheric disturbances driven by solar eruptive events such as flares, CMEs, SEPs and CIRs (assoc. with Q1-1,Q1-2,Q1-3) | **(M1-2)** Identifying and characterizing solar eruptive events and the consequent space weather conditions | Photospheric Vector Magnetograph, H-alpha Imaging Spectrograph, EUV Imager, Coronagraph, Helispheric Imager, X-ray Spectrometer, FIELDS, Solar Wind Plasma Detector, Energetic Particle Detector |
| | **(Q1-3)** Forecast - How can we enhance space weather forecasting capabilities? | **(O1-3)** Investigating the nominal heliospheric environment: solar wind, electric and magnetic fields, dust particles (assoc. with Q1-2,Q1-3) | **(M1-3)** Monitoring the heliospheric environment: solar wind, electric and magnetic fields, dust particles | FIELDS, Solar Wind Plasma Detector, Energetic Particle Detector, Dust Detector |
| | | **(O1-4)** Improving the accuracy of space weather forecasting models through multi-point obsevations (assoc. with Q1-1,Q1-2,Q1-3) | | |
| 2. Magnetized plasma structures erupting from the Sun: initiation and dynamic evolution | **(Q2-1)** How do solar eruptions form, accelerate and evolve through the solar corona and the inner heliosphere? | **(O2-1)** Physical properties of flare-CME productive active regions and Initiation of CMEs (assoc. with Q3-1,Q3-2) | **(M2-1)** Deriving the characteristics of CME-productive solar active regions | Photospheric Vector Magnetograph, H-alpha Imaging Spectrograph, EUV Imager, Coronagraph, X-ray Spectrometer |
| | **(Q2-2)** What are the three-dimensional characteristics of CMEs? How do CMEs evolve and propagate in the interplanetary space? | **(O2-2)** Tracking 3D CMEs propagation and evolution (assoc. with Q3-1,Q3-2,Q3-3) | **(M2-2)** Determining the 3D propagation and evolution of CMEs from the Sun into interplanetary space | Coronagraph, Helispheric Imager, FIELDS, Solar Wind Plasma Detector, Energetic Particle Detector |
| | **(Q2-3)** How do global and small-scale structures of the solar wind plasma form in the inner heliosphere? | **(O2-3)** Global and local structures of heliospheric plasma (assoc. with Q3-2,Q3-3) | **(M2-3)** 1-AU magnetized plasma structures and properties from large to small scales | FIELDS, Solar Wind Plasma Detector, Energetic Particle Detector, Helispheric Imager |
| 3. Solar energetic particles: origin, properties and propagation characteristics | **(Q3-1)** Injection - What are the seed populations for energetic particles? How and where are the seed particle populations injected into the acceleration mechanism (i.e., the birthplace of SEPs)? | **(O3-1)** Statistical analysis of event-to-event variations in SEP properties (assoc. with Q2-1,Q2-2,Q2-3) | **(M3-1)** Remote-sensing observations of geoeffective SEP source regions (assoc. with O2-1) | Photospheric Vector Magnetograph, H-alpha Imaging Spectrograph, EUV Imager, Coronagraph, Helispheric Imager, X-ray Spectrometer |
| | **(Q3-2)** Acceleration - how and where are energetic particles accelerated at the Sun and in the interplanetary medium? | **(O3-2)** Extreme SEP events: origin and radiation impact on the heliosphere (assoc. with Q2-1,Q2-2,Q2-3) | **(M3-2)** Deriving the physical properties of SEP-related solar eruptions (assoc. with O2-1,O2-2,O2-3) | Photospheric Vector Magnetograph, H-alpha Imaging Spectrograph, EUV Imager, Coronagraph, Helispheric Imager, X-ray Spectrometer |

# Science Traceability Matrix

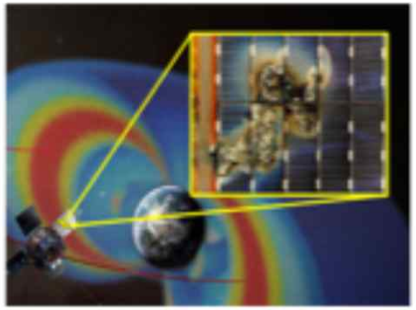
| Major Science Themes | Major Open Questions | Science Objectives | Measurements Required from L4 | Relevant Science Payloads | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | PVM | CHRIS | EUVI | WLCC | HI | CXIS | FGM | SCM | RPW | SWPD | HEPD | RM | DD |
| 1. Space weather | (Q1-1) Solar activities | (O1-1) Solar source regions (Q1-1-3) | (M1-1) Magnetic field and plasma properties | X | X | X | | | X | | | | | | | |
| | (Q1-2) Heliospheric environment | (O1-2) Flares, CMEs, SEPs and CIRs (Q1-1-3) | (M1-2) Their characteristics | X | X | X | X | X | X | X | X | X | X | X | X | |
| | (Q1-3) Forecast | (O1-3) Nominal heliospheric environment (Q1-2-3) | (M1-3) Monitoring the heliospheric environment | | | | | | | X | X | X | X | X | X | X |
| | | (O1-4) Space weather forecasting models (Q1-1-3) | | | | | | | | | | | | | | |
| 2. CME | (Q2-1) Solar eruptions | (O2-1) CME initiation (Q3-1-2) | (M2-1) Solar active regions | X | X | X | X | | X | | | | | | | |
| | (Q2-2) CMEs' structure, evolution, and propagation | (O2-2) 3D CME propagation and evolution (Q3-1-3) | (M2-2) 3D CME propagation and evolution | | | | X | X | | X | X | X | X | X | X | |
| | (Q2-3) Global and small-scale structures of heliospheric plasma | (O2-3) Global and local structures of solar wind plasma (Q3-2-3) | (M2-3) Plasma structures and properties at 1 AU | | | | | X | | X | X | X | X | X | X | |
| 3. SEP | (Q3-1) Generation of SEPs | (O3-1) SEP properties (Q2-1-3) | (M3-1) SEP source regions (O2-1) | X | X | X | X | X | X | | | | | | | |
| | (Q3-2) Acceleration of SEPs | (O3-2) Origin and radiation impact (Q2-1-3) | (M3-2) Properties of solar eruptions (O2-1-3) | X | X | X | X | X | X | | | | | | | |
| | (Q3-3) Transport of SEPs | (O3-3) Energization and propagation of SEPs (Q2-1-3) | (M3-3) Contribution to the radiation environment (O2-1-3) | X | X | X | X | X | X | X | X | X | X | X | X | |

| | Measurement Requirements |
|---|---|
| Remote Sensing | **Photospheric Vector Magnetograph (PVM)**<br>Fe I; full-disk |
| | **CHRomospheric Imaging Spectrograph (CHRIS)**<br>Hα; full-disk |
| | **Extreme UltraViolet Imager (EUVI)**<br>13.3, 17.1, 19.3, 30.4 nm; <6 Rs |
| | **White-Light Compact Coronagraph (WLCC)**<br>White light; 3.0-23.5 Rs |
| | **Heliospheric Imager (HI)**<br>White light; FOVs: 30°and 50° |
| | **Compact X-ray Imaging Spectrometer (CXIS)**<br>X-ray; full Sun |
| FIELDS | **Fluxgate Magnetometer (FGM)**<br>Magnetic field 3 comp.; DC to 128 Hz |
| | **Search Coil Magnetometer (SCM)**<br>Magnetic field 3 comp.; <55 kHz |
| | **Radio and Plasma Wave Detector (RPW)**<br>Electric field 3 comp.; DC to 16 MHz |
| PARTICLES | **Solar Wind Plasma Detector (SWPD)**<br>Ions and electrons; 1 eV - 30 keV |
| | **High Energy Particle Detector (HEPD)**<br>Ions (30 keV - 100 MeV/nuc) and electrons (30 keV - 2 MeV) |
| | **Radiation Monitor (RM)**<br>Protons (1-500 MeV) and electrons (0.2-1,000 keV/μm) |
| Dust | **Dust Detector (DD)**<br>Dust grains >50 nm |

| Mission Requirements |
|---|
| **Precise Attitude for Remote Sensing Payloads** |
| **Low-noise environment for precise magnetic field measurements** |
| **Unique perpective of Sun's western side** |
| **Long lifetime for solar cycle activies** |
| **Handle a large number of payloads and their datas** |
| **Enable near-realtime data handling for solar weather forecasting purposes** |

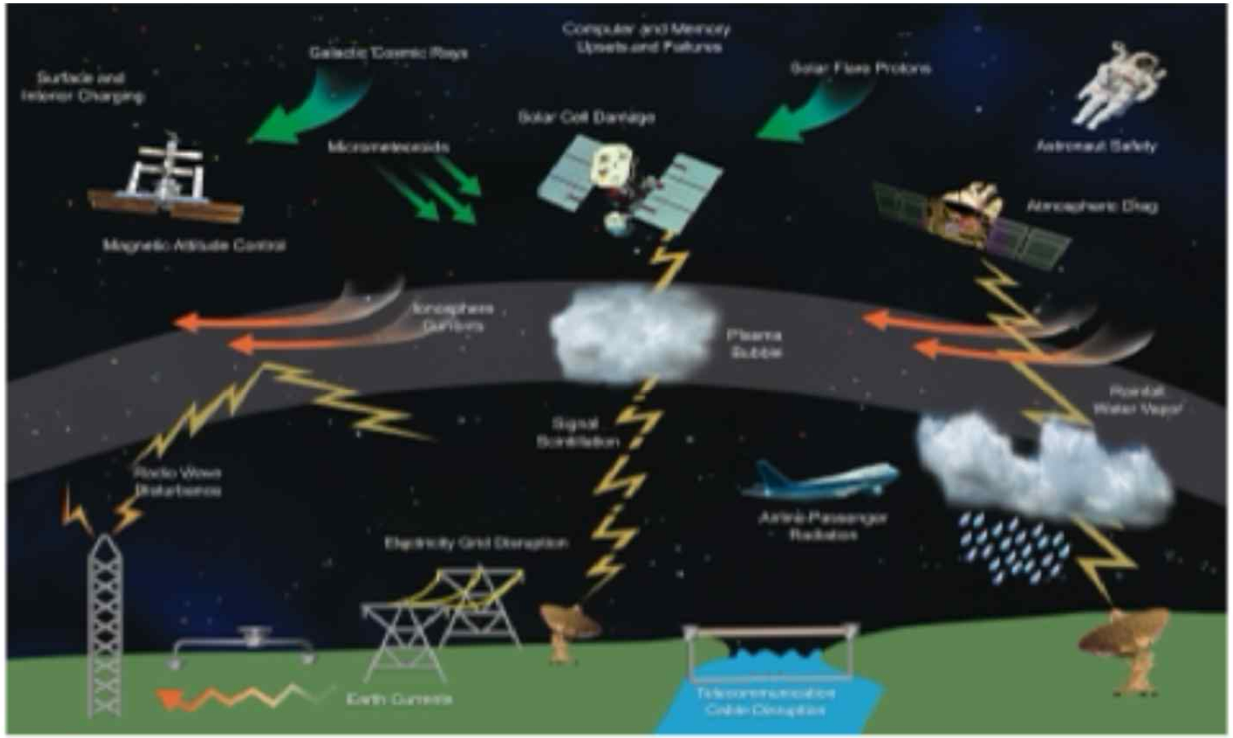
# Scientific
# & Social Benefits

# Benefits: More reliable Space Weather Forecasting



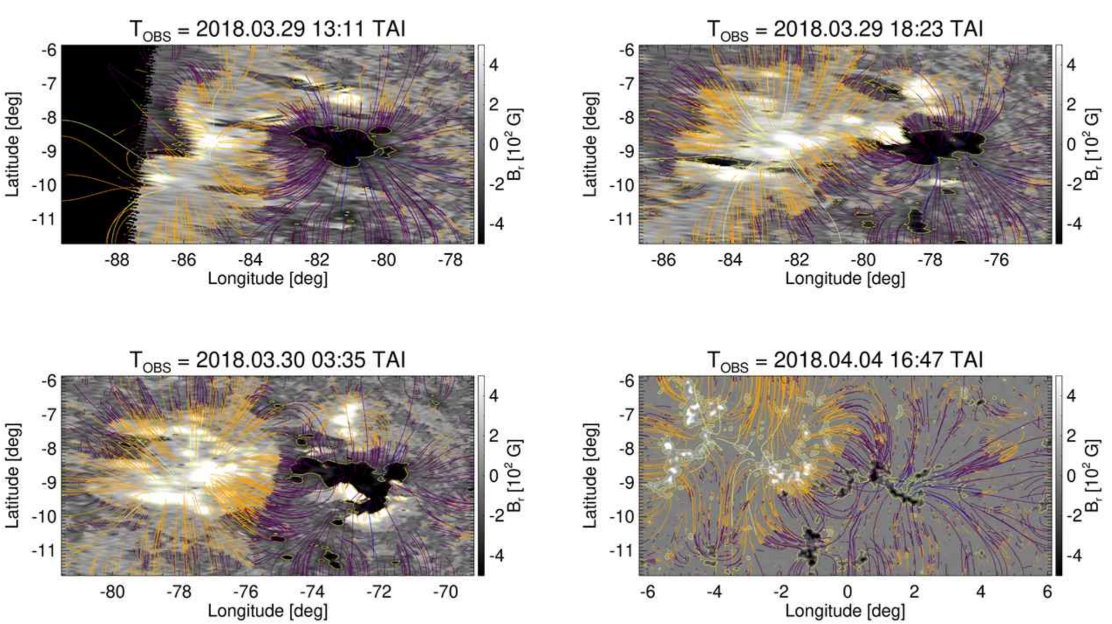
PJM Public Service
Step Up Transformer

Severe internal damage caused by the space storm of 13 March, 1989.

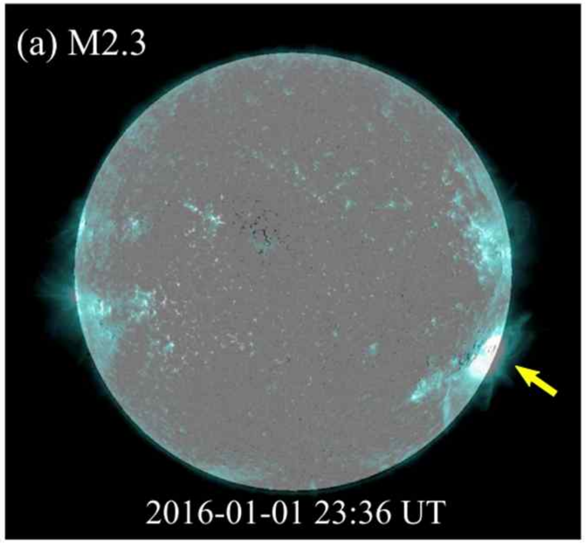


- Forecasts are used to support activities that are impacted by space weather such as electric power transmission, satellite operation, humans in space, navigation, and communication.
- **Probabilty of accurately forecasting of solar flares and geomagnetic storms is very low.**
- The L4 mission will significantly contribute to improve space weather forecasting capability.

# For Example: Flare Forecasting

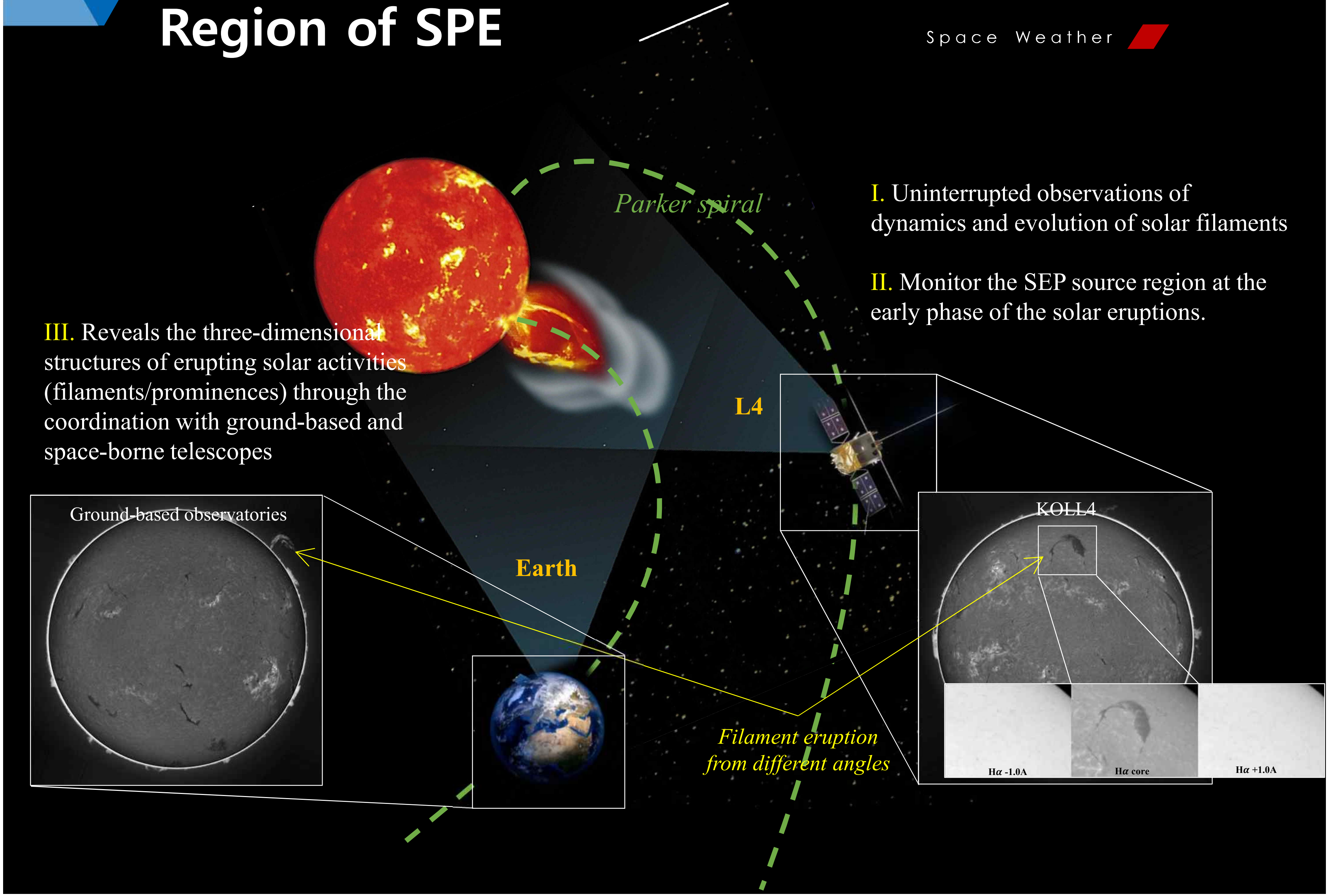


Effect of SDO/HMI Radial Magnetic Field Map Projections



- 2017: International Workshop on Solar Flare Forecast Model Evaluation by ISEE
- Performance evaluation of a total of 19 flare forecast models (including U.S./NOAA, U.K. Meteorological Office, Japan/NICT, etc.)
- During the 2016-2017 evaluation period, all models failed to forecast for 15% of the total number of M-class or higher flares.
- All correspond to flares that occurred at the edge
- **L4 can help better prediction of such flares**

# Benefits: Direct Observations the Source Region of SPE

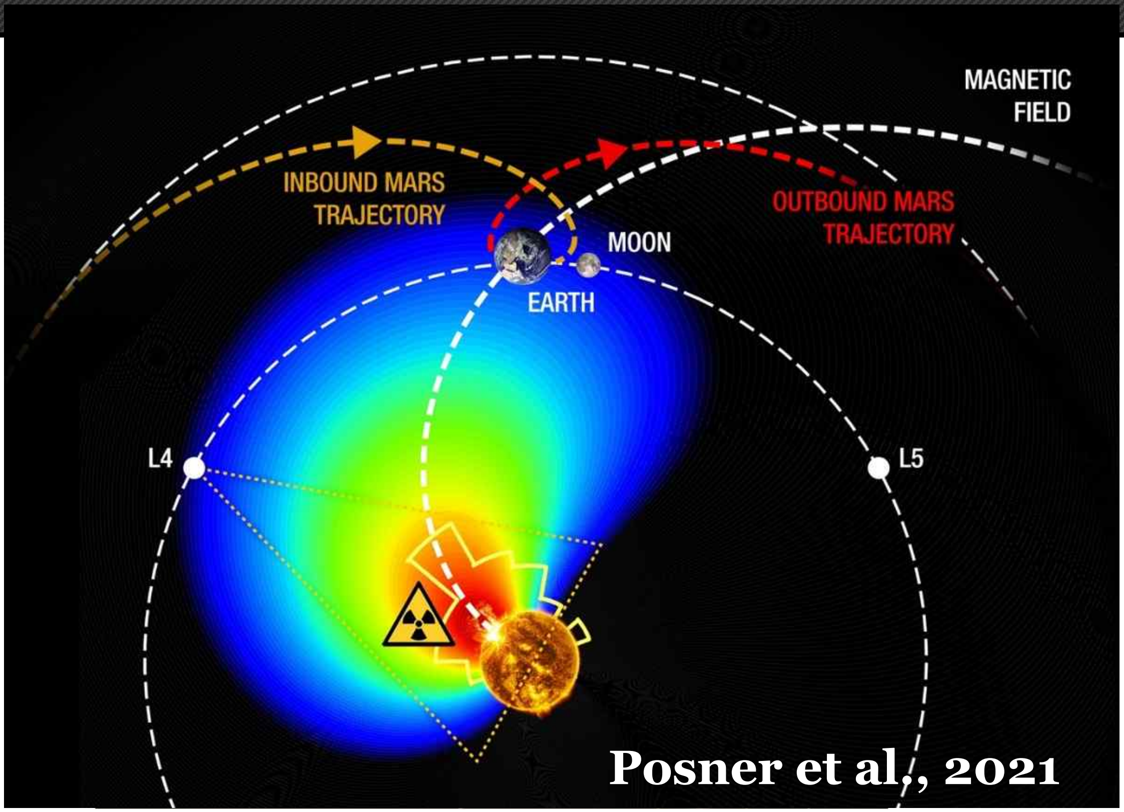


I. Uninterrupted observations of dynamics and evolution of solar filaments

II. Monitor the SEP source region at the early phase of the solar eruptions.

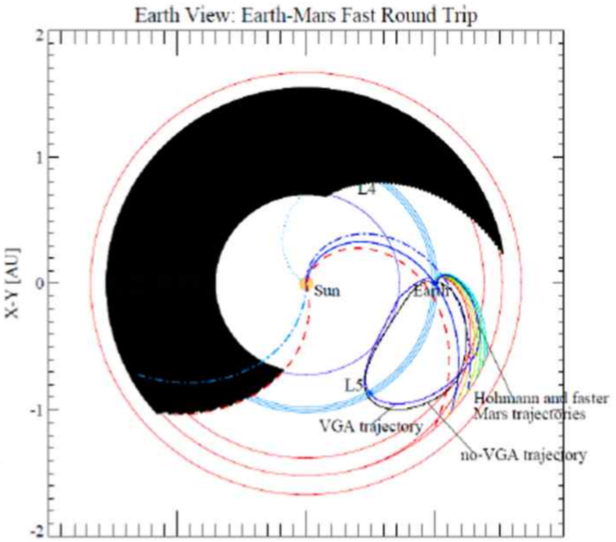
III. Reveals the three-dimensional structures of erupting solar activities (filaments/prominences) through the coordination with ground-based and space-borne telescopes

# Benefits:  Speed up Solar radiation detection

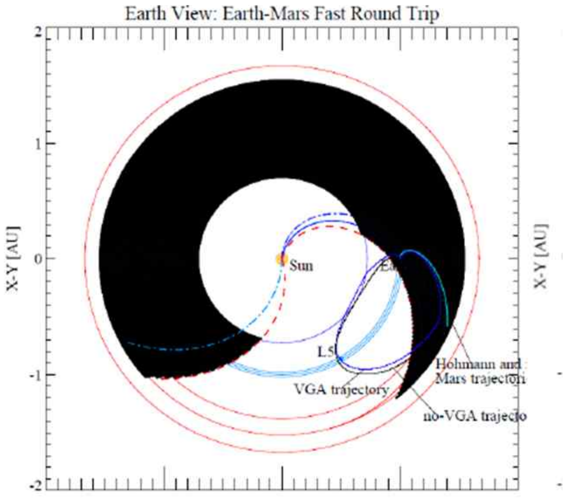


Posner et al., 2021

- L4 is a meta-stable locations at 1 AU and the best location for a solar remote sensing observatory that would **oversee the entire solar radiation hemisphere.**
- The unusual attribute of L4 is that it covers entire “Solar Radiation Hemisphere” that is relevant for M2M architecture.

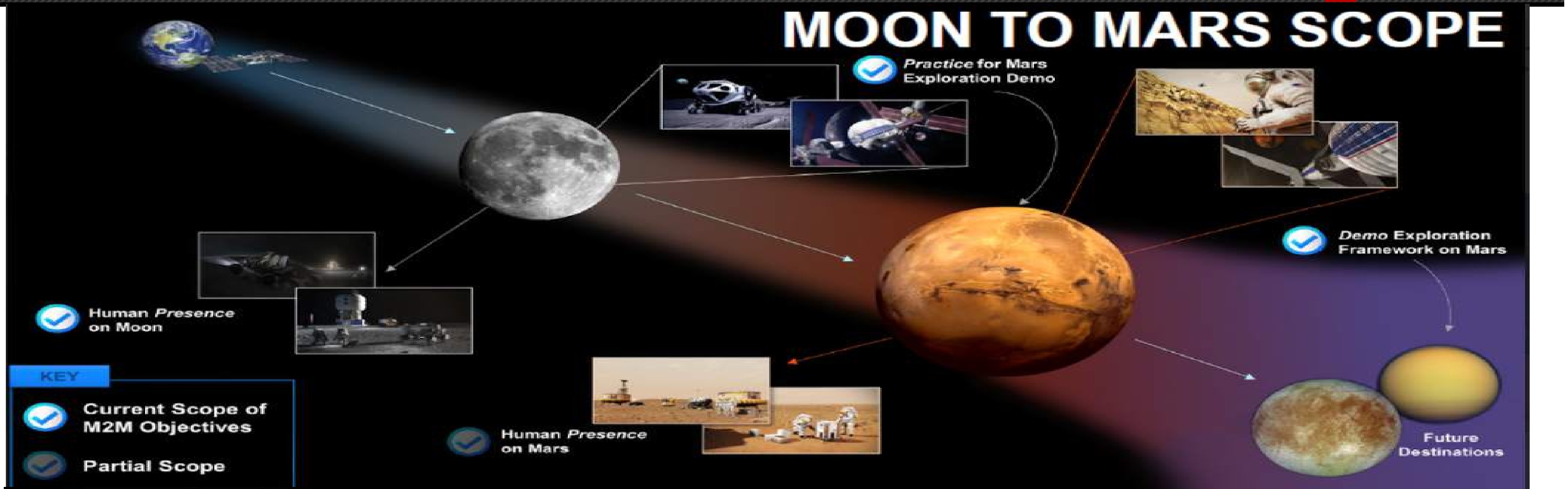


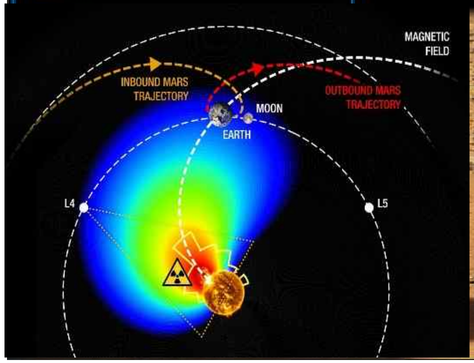
SWx Safety Zone supported by L1 and L4[1]



SWx Safety Zone supported by L1 onl

# Benefits: Expanding of Space Weather to M2M



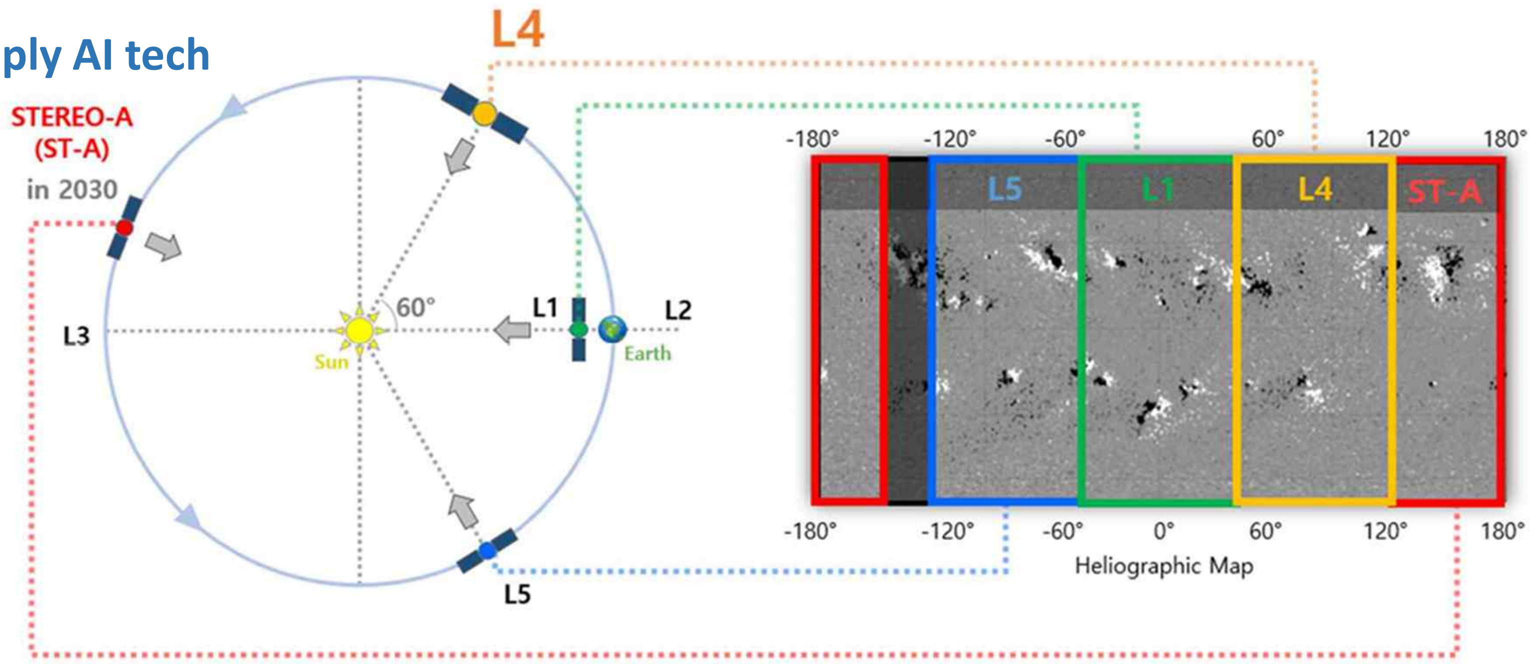


- Through continuous observation of the heliosphere at the L4 position, we can provide more **reliable space weather forecast and space radiation environment information** for deep space exploration to the Moon and Mars.

OSEL: Off-Sun-Earth-Line

# Opportunity for New Science: OSEL Mission

Apply AI tech



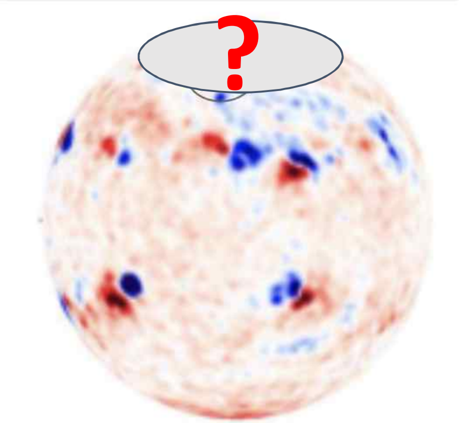
## More reliable synoptic map from multi-view observations

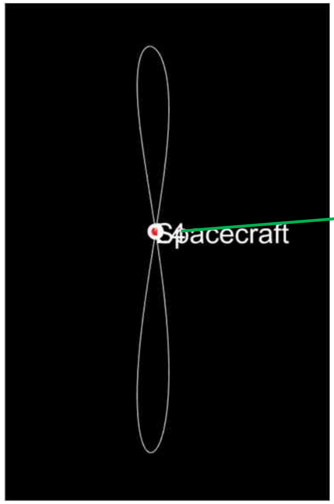
: The L4 mission will contribute to generate a near real-time synoptic map constructed from multi-viewpoint observations of the photospheric vector magnetic field at L4 + L1, L5, and ground.

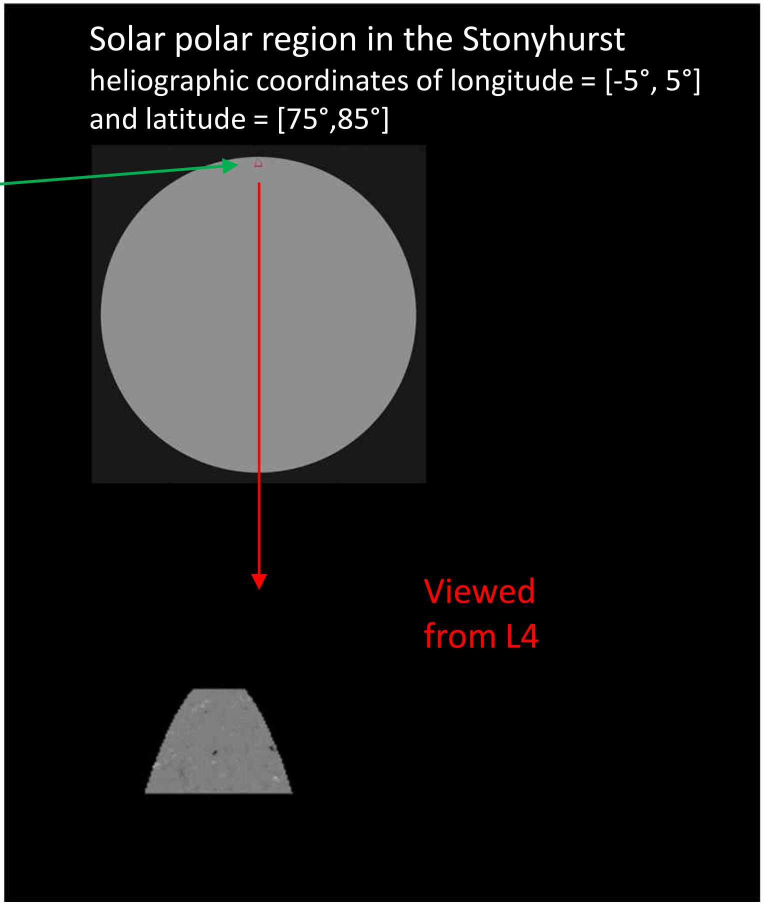
# Contributing to Sun’s Polar Observation

## Seeing solar polar region

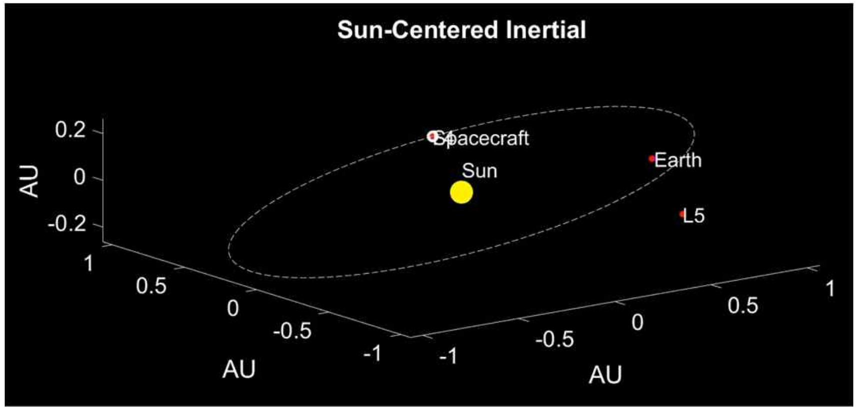
: L4, in coordination with ESA/NASA Solar Orbiter, will open new science that has never been studied in detail before such as **the structure of the Sun’s polar region, large scale flows from the Sun’s low latitude to high latitude, and the evolution of the solar magnetic fields and their effect on the next solar cycle**






Solar polar region in the Stonyhurst heliographic coordinates of longitude = [-5°, 5°] and latitude = [75°,85°]

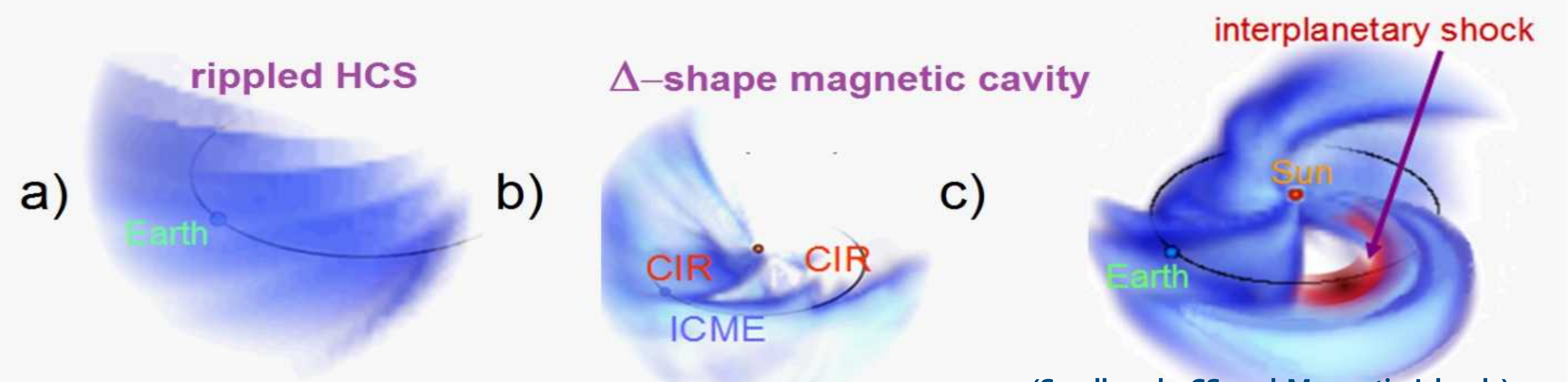
Viewed from L4



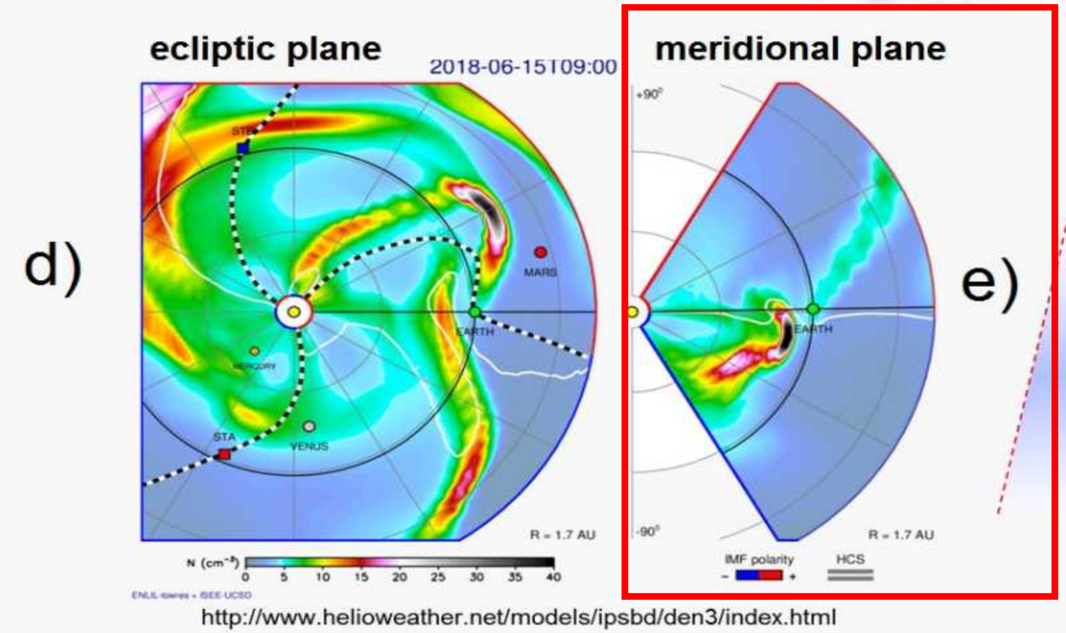
# Benefits: 3D Heliospheric Structure

## Contribute to understand 3D Heliospheric Structure

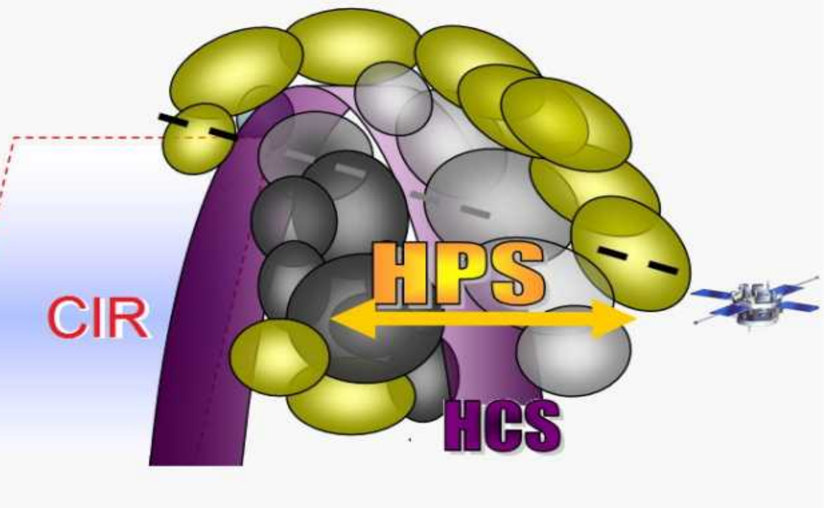
Olga Khabarova et al., (2021)



(Small scale CS and Magnetic Islands)



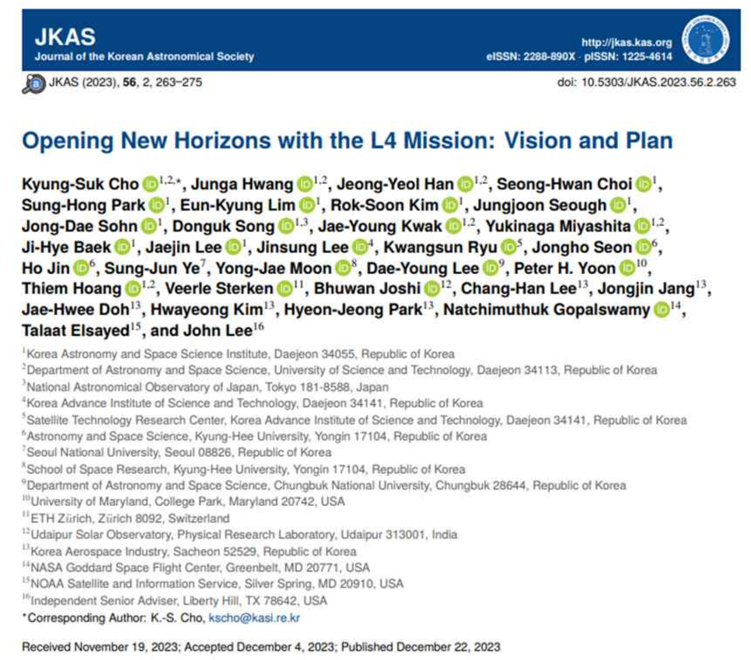
http://www.helioweather.net/models/ipsbd/den3/index.html



Heliospheric Plasma Sheet (HPS)

# References of the L4 Mission

Science Publications



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doi: 10.5303/JKAS.2023.56.2.263

## Opening New Horizons with the L4 Mission: Vision and Plan

**Kyung-Suk Cho**[1,2,*], **Junga Hwang**[1,2], **Jeong-Yeol Han**[1,2], **Seong-Hwan Choi**[1], **Sung-Hong Park**[1], **Eun-Kyung Lim**[1], **Rok-Soon Kim**[1], **Jungjoon Seough**[1], **Jong-Dae Sohn**[1], **Donguk Song**[1,3], **Jae-Young Kwak**[1,2], **Yukinaga Miyashita**[1,2], **Ji-Hye Baek**[1], **Jaejin Lee**[1], **Jinsung Lee**[4], **Kwangsun Ryu**[5], **Jongho Seon**[6], **Ho Jin**[6], **Sung-Jun Ye**[7], **Yong-Jae Moon**[8], **Dae-Young Lee**[9], **Peter H. Yoon**[10], **Thiem Hoang**[1,2], **Veerle Sterken**[11], **Bhuwan Joshi**[12], **Chang-Han Lee**[13], **Jongjin Jang**[13], **Jae-Hwee Doh**[13], **Hwayeong Kim**[13], **Hyeon-Jeong Park**[13], **Natchimuthuk Gopalswamy**[14], **Talaat Elsayed**[15], and **John Lee**[16]

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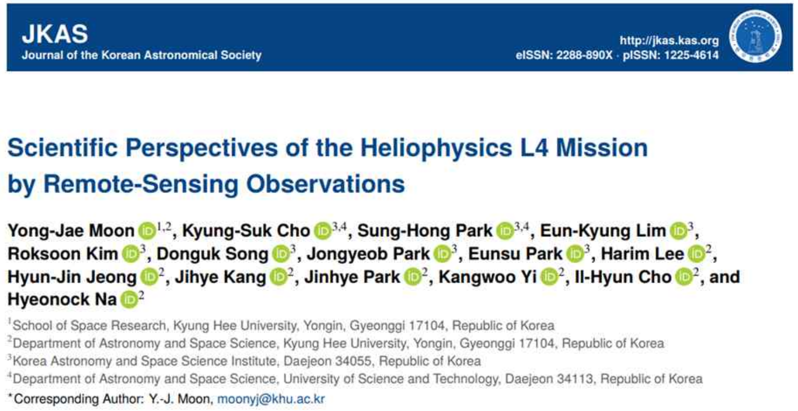

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## Scientific Perspectives of the Heliophysics L4 Mission by Remote-Sensing Observations

**Yong-Jae Moon**[1,2], **Kyung-Suk Cho**[3,4], **Sung-Hong Park**[3,4], **Eun-Kyung Lim**[3], **Roksoon Kim**[3], **Donguk Song**[3], **Jongyeob Park**[3], **Eunsu Park**[3], **Harim Lee**[2], **Hyun-Jin Jeong**[2], **Jihye Kang**[2], **Jinhye Park**[2], **Kangwoo Yi**[2], **Il-Hyun Cho**[2], and **Hyeonock Na**[2]

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*Corresponding Author: Y.-J. Moon, moonyj@khu.ac.kr

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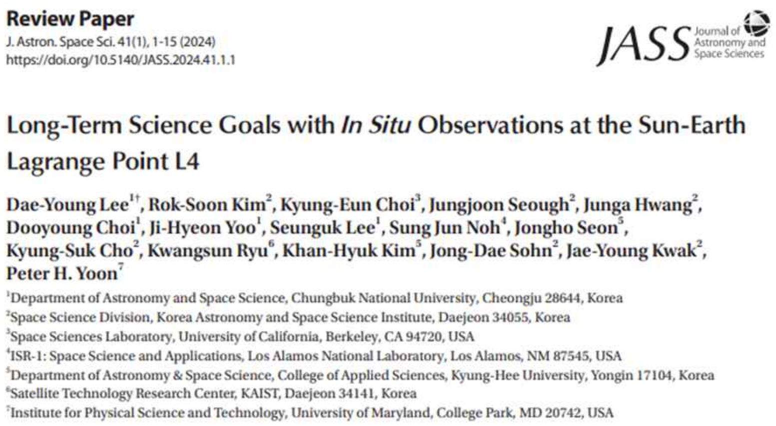

**Review Paper**
J. Astron. Space Sci. 41(1), 1-15 (2024)
https://doi.org/10.5140/JASS.2024.41.1.1

JASS Journal of Astronomy and Space Sciences

## Long-Term Science Goals with *In Situ* Observations at the Sun-Earth Lagrange Point L4

Dae-Young Lee[1†], Rok-Soon Kim[2], Kyung-Eun Choi[3], Jungjoon Seough[2], Junga Hwang[2], Dooyoung Choi[1], Ji-Hyeon Yoo[1], Seunguk Lee[1], Sung Jun Noh[4], Jongho Seon[5], Kyung-Suk Cho[2], Kwangsun Ryu[6], Khan-Hyuk Kim[5], Jong-Dae Sohn[2], Jae-Young Kwak[2], Peter H. Yoon[7]

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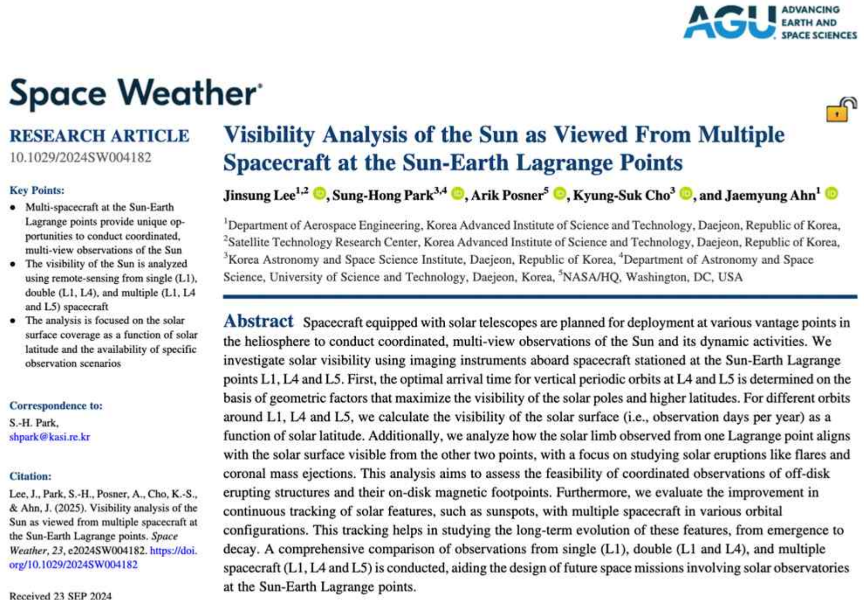

AGU ADVANCING EARTH AND SPACE SCIENCES

Space Weather

RESEARCH ARTICLE
10.1029/2024SW004182

## Visibility Analysis of the Sun as Viewed From Multiple Spacecraft at the Sun-Earth Lagrange Points

**Jinsung Lee**[1,2], **Sung-Hong Park**[3,4], **Arik Posner**[5], **Kyung-Suk Cho**[3], **and Jaemyung Ahn**[1]

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**Key Points:**

- Multi-spacecraft at the Sun-Earth Lagrange points provide unique opportunities to conduct coordinated, multi-view observations of the Sun
- The visibility of the Sun is analyzed using remote-sensing from single (L1), double (L1, L4), and multiple (L1, L4 and L5) spacecraft
- The analysis is focused on the solar surface coverage as a function of solar latitude and the availability of specific observation scenarios

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**Citation:**
Lee, J., Park, S.-H., Posner, A., Cho, K.-S., & Ahn, J. (2025). Visibility analysis of the Sun as viewed from multiple spacecraft at the Sun-Earth Lagrange points. *Space Weather*, *23*, e2024SW004182. https://doi.org/10.1029/2024SW004182

Received 23 SEP 2024

**Abstract** Spacecraft equipped with solar telescopes are planned for deployment at various vantage points in the heliosphere to conduct coordinated, multi-view observations of the Sun and its dynamic activities. We investigate solar visibility using imaging instruments aboard spacecraft stationed at the Sun-Earth Lagrange points L1, L4 and L5. First, the optimal arrival time for vertical periodic orbits at L4 and L5 is determined on the basis of geometric factors that maximize the visibility of the solar poles and higher latitudes. For different orbits around L1, L4 and L5, we calculate the visibility of the solar surface (i.e., observation days per year) as a function of solar latitude. Additionally, we analyze how the solar limb observed from one Lagrange point aligns with the solar surface visible from the other two points, with a focus on studying solar eruptions like flares and coronal mass ejections. This analysis aims to assess the feasibility of coordinated observations of off-disk erupting structures and their on-disk magnetic footpoints. Furthermore, we evaluate the improvement in continuous tracking of solar features, such as sunspots, with multiple spacecraft in various orbital configurations. This tracking helps in studying the long-term evolution of these features, from emergence to decay. A comprehensive comparison of observations from single (L1), double (L1 and L4), and multiple spacecraft (L1, L4 and L5) is conducted, aiding the design of future space missions involving solar observatories at the Sun-Earth Lagrange points.

# III

# Payload & Spacecraft

# Science Payloads

- Remote Instruments

🟩 L5 instruments

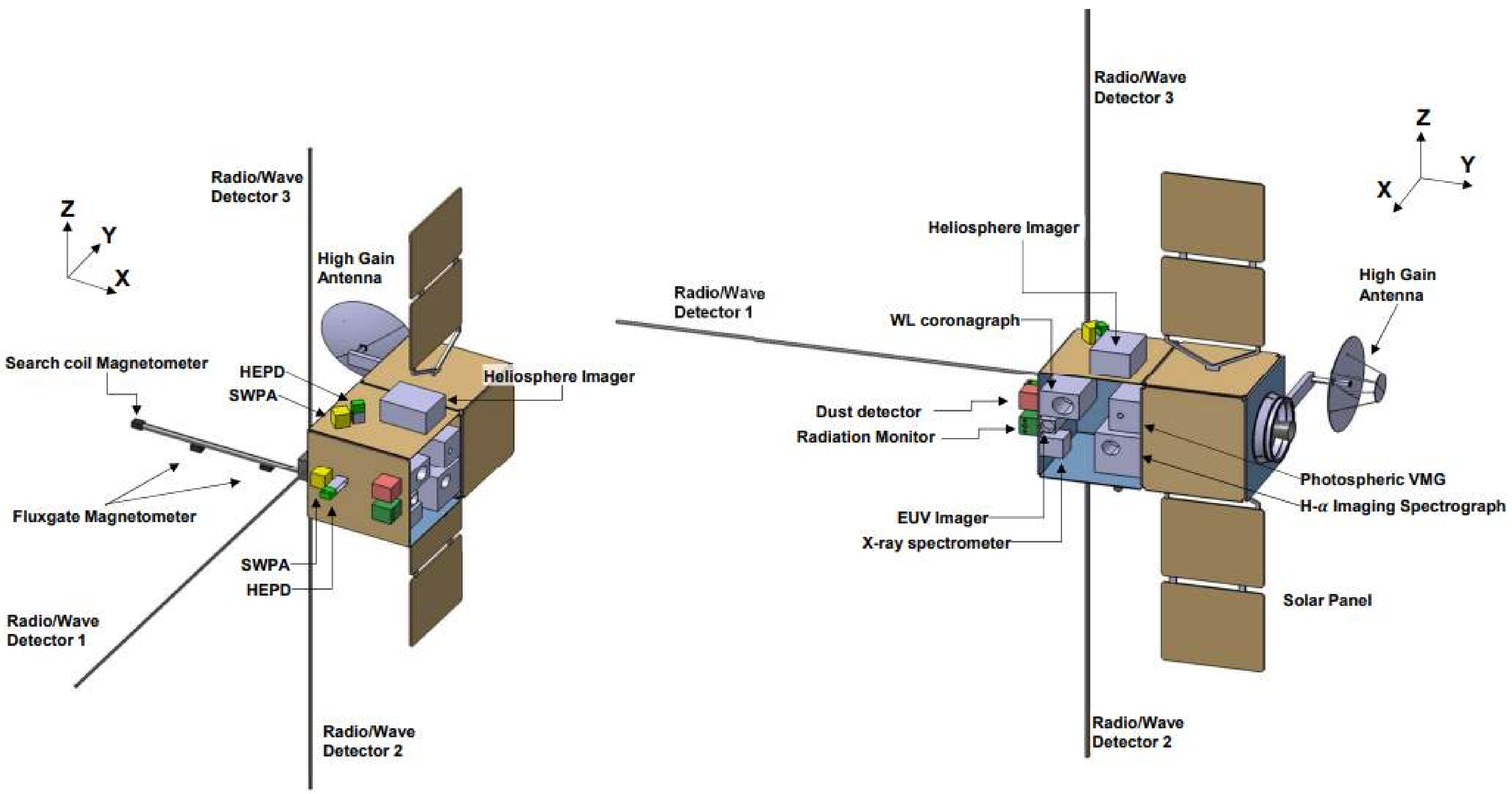
| | Size (L×W×H) (cm) | Weight (kg) | Power (W) | Spatial Resolution (arcsec) | Time Cadence (min) | Telemetry (kbps) |
|---|---|---|---|---|---|---|
| Photospheric VMG | 70×40×50 | 23 | 40 | 2 | $\leq 30$ | 60 |
| H$\alpha$ Imaging Spectrograph | 70×40×50 | 23 | 40 | 2–5 | $\leq 5$ | 60 |
| EUV Imager | 70×20×20 | 30 | 35 | $\sim 8$ | 2–10 | 70 |
| WL Coronagraph | 90×50×50 | 22 | 14.2 | 65 | 15 | 38.7 |
| Heliosphere Imager | 60×40×50 | 16.5 | 13.5 | 360 | 15–60 | 70 |
| X-ray Spectrometer | 30×30×30 | 15 | 15 | 1–5 keV @ 1–150 keV | 1 sec | 40 |
| Total | — | 129.5 | 157.7 | — | — | 338.7 |

- In-situ Instruments

🟥 Particle package 🟦 Field Package

| | Size (L×W×H) (cm) | Weight (kg) | Power (W) | Time Resolution | Measurement Resolution | Telemetry (kbps) |
|---|---|---|---|---|---|---|
| Solar Wind Plasma Analyzer (SWPA) | 20×20×25 | 3.75 | 5 | 30 sec | $\Delta E/E < 20\%$ | 4 |
| High Energy Particle Detector (HEPD) | 10×15.6×14.7 | 5 | 5 | 1 min | $\Delta E/E < 20\%$ | 4 |
| Fluxgate Magnetometer | Boom: 300×10×15 | 7.2 | 13 | 32 Hz | 0.1 nT | 0.4 |
| Search Coil Magnetometer | Boom: 300×10×15 | 1.8 | 1.4 | 0.1–0.4 kHz | $<1$ pT @ 10 Hz | 0.24 |
| Radiation Monitor (RM) | 27×27×27 | 7.5 | 5.1 | 1 sec | $<10\%$ | 0.4 |
| Radio/Wave Detector | 600×2.5×2.5 | 10 | 5.6 | 16 sec | $16\ \mathrm{nV}/\sqrt{\mathrm{Hz}}$ | 4.5 |
| Dust Detector | 30×30×30 | 12.5 | 25 | — | $\Delta M/M = 100–200$ | 0.2 (12.6 MB/week) |
| Total | — | 47.75 | 60.1 | — | — | 13.74 |

# L4 Spacecraft



Concept design based on the GEO-KOMSAT platform

# Mission Design (Preliminary)

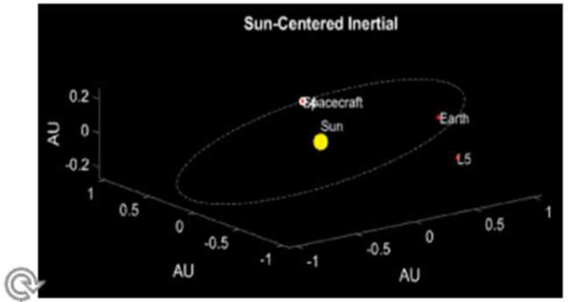
POI; Phasing Orbit Insertion

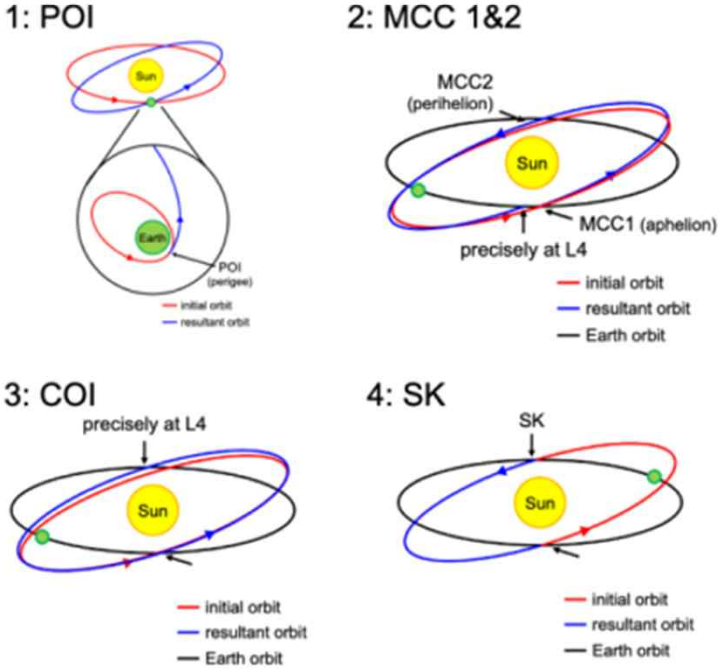
Inclination: 10° Delta V: 1.954 km/s Launch '35. 3

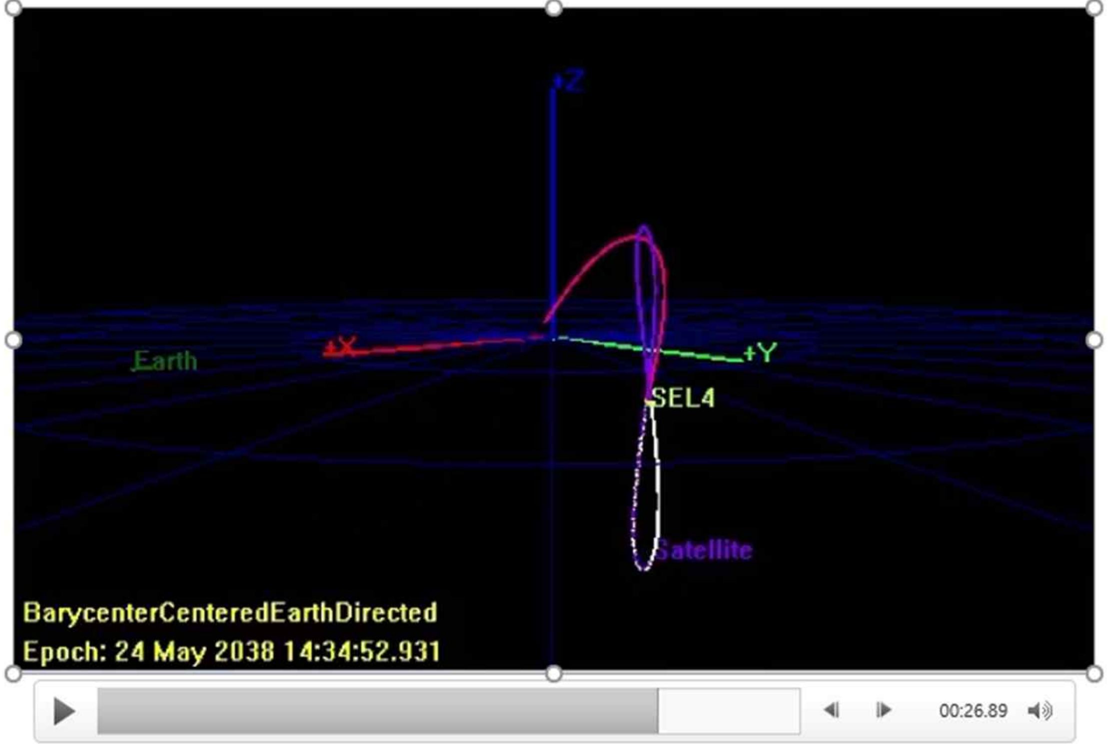
MCC1, MCC2; Mid Course Correction

COI; Circular Orbit Insertion

SK; Station Keeping

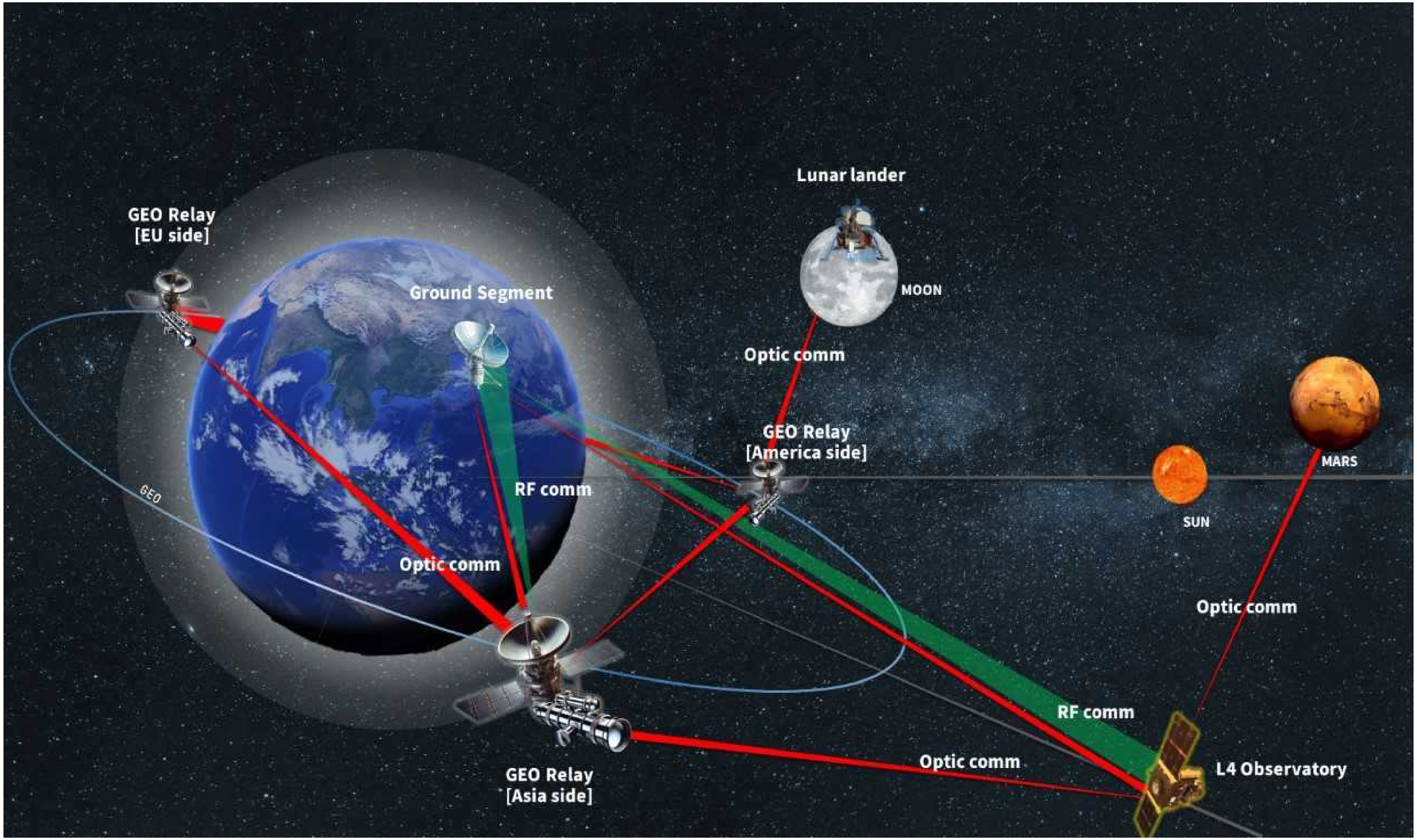




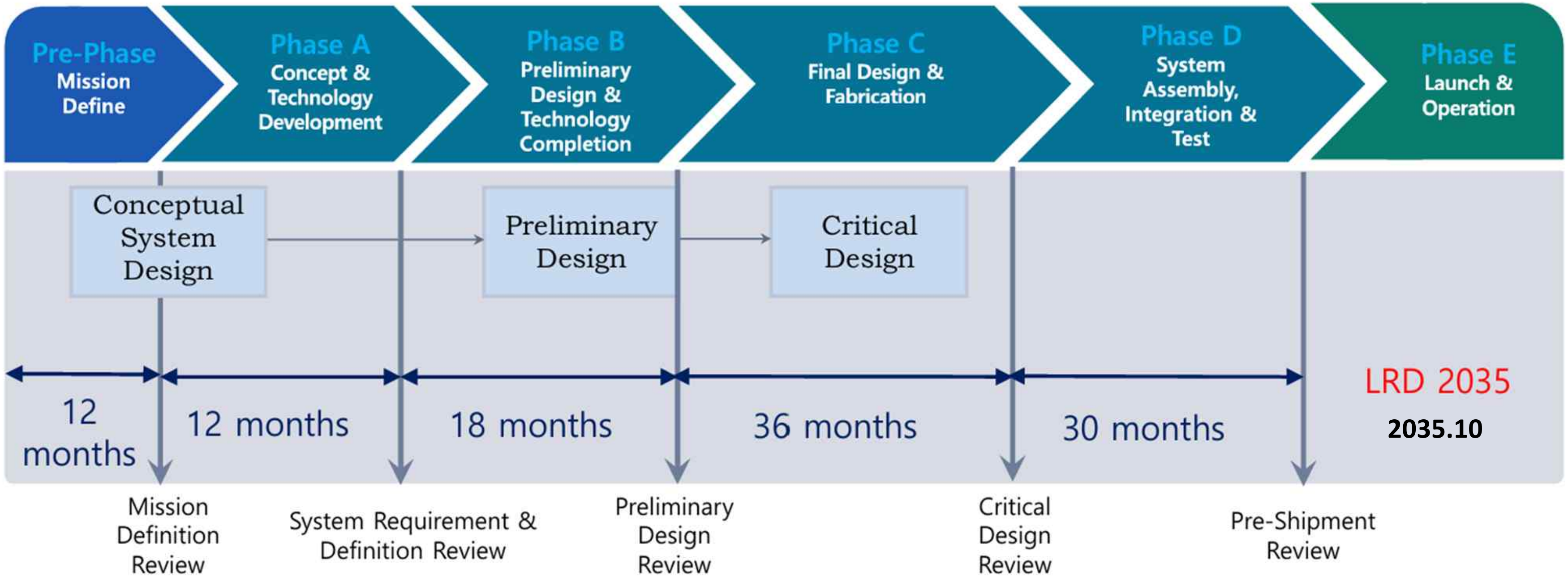


Courtesy: Dr. Jinsung Lee, KAIST

# KASA DSOC Concept (TBD)



# Roadmap



Pre-Phase
Mission Define

Phase A
Concept & Technology Development

Phase B
Preliminary Design & Technology Completion

Phase C
Final Design & Fabrication

Phase D
System Assembly, Integration & Test

Phase E
Launch & Operation

Conceptual System Design

Preliminary Design

Critical Design

12 months

12 months

18 months

36 months

30 months

LRD 2035

2035.10

Mission Definition Review

System Requirement & Definition Review

Preliminary Design Review

Critical Design Review

Pre-Shipment Review

2026.1

2028.1

2029.6

2032.6

LRD: Launch Readiness Date

# IV

# International Collaboration

# International Collaborations (TBD)

- NASA
  - Align with the Decadal Survey
  - Collaborate with Sun CHASER and MOST
  - LOI for Solar EUV instrument from NASA/JPL
  - Contribute NASA's Deep Space Networking for downlinking data from the mission
  - Study for L4 contribution to M2M
- NOAA
  - Completed the Letter Of Intent (LOI) between KASI and NOAA/NESDI for a Compact Solar coronagraph
  - Share science and operation data
  - Use of NOAA's ground stations for downlinking (possibly)
- ESA
  - Align with the L5 mission and share science and operation data
  - 32 m Antenna Conversion for L4 mission (Greece)
- Max Plank Institute (Solar System Research)
  - Collaborate on Polarimetric and Helioseismic Imager (PHI)
- UK
  - Collaborate on Heliosphere Imager (HI, RAL-SPACE)
  - Collaborate on Solar wind detector (Electrostatic Analyzer, UCL)
- Japan
  - Discuss with NAOJ, ISAS, Nagoya and Kyoto Universities
  - Collaborate on Radio and Plasma Wave (RPW, CNES)
- Other nations
  - Swiss: Find partner nations for dust detector

# JPL Team-X at JPL, Feb 11 – 13, 2025

## JPL Formulation - Finding the Optimal Solution for L4

# KASA-NASA L4 SG Kick-off meeting at GSFC, March 11 – 14, 2025

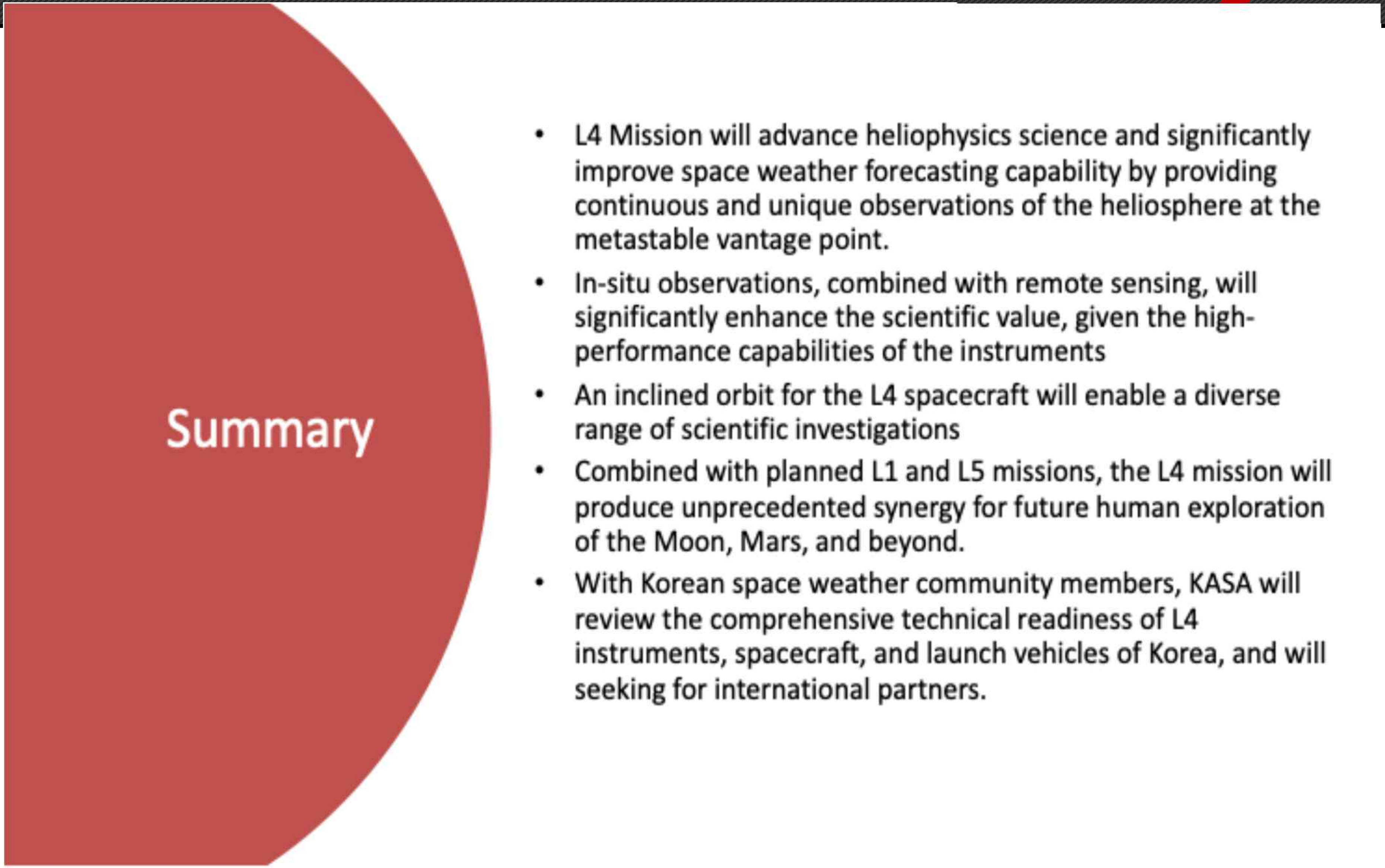
Group1: Optical Comm

Group2: Space Weather

Group3: Space Radiation

KASA-NASA Study Group

# Summary



## Summary

- L4 Mission will advance heliophysics science and significantly improve space weather forecasting capability by providing continuous and unique observations of the heliosphere at the metastable vantage point.
- In-situ observations, combined with remote sensing, will significantly enhance the scientific value, given the high-performance capabilities of the instruments
- An inclined orbit for the L4 spacecraft will enable a diverse range of scientific investigations
- Combined with planned L1 and L5 missions, the L4 mission will produce unprecedented synergy for future human exploration of the Moon, Mars, and beyond.
- With Korean space weather community members, KASA will review the comprehensive technical readiness of L4 instruments, spacecraft, and launch vehicles of Korea, and will seeking for international partners.

# Thank You

KASI 한국천문연구원
Korea Astronomy & Space Science Institute