Canadian Space Exploration Strategic Plan

The Canadian Space Agency (CSA) has engaged in an exercise to create a new/updated strategic plan for **Space Exploration**.

Plan includes space exploration in the areas of **Planetary Science**, **Space Astronomy,** and **Astronaut Health**.

Previous plan goes back to **2017**.

Planning exercise involves reach out to and engagement and consultation with the Canadian science community in the area of space exploration and to produce a consensus report that prioritizes science and research activities and investigations based upon scientific merit, importance to the community, as well as benefits to Canada.

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Strategic planning exercise is organized into 10 topical teams:

- Space Astronomy - Cosmic Origins
- Space Astronomy - Stellar and Galaxy Evolution
- Space Astronomy - High Energy Astrophysics and Gravitational Waves
- Space Astronomy - Exoplanets
- Planetary Science - Astrobiology
- Planetary Science - Planetary Atmospheres
- Planetary Science - Planetary Geology and Geophysics
- **Planetary Science - Planetary Space Environment**
- Planetary Science - Planetary Prospecting for Resources
- Astronaut Health

Planetary Space Environment Topical Team

Focus:
In the context of space exploration, planetary space environment science is concerned with the study of the fundamental physics of and connections between the Sun and planets (and other bodies) in the solar system, and to improve our ability to forecast and mitigate the resulting effects on human and robotic exploration.

Some Key Questions:
What are the plasma processes that shape the heliosphere and drive planetary and interplanetary space weather?
What is the role of the magnetic fields, plasma, and atmosphere-ionosphere dynamics on the evolution of planets and other solar-system bodies?

Planetary Space Environment Topical Team

Name	Affiliation
Clinton Groth (Chair)	University of Toronto
John Manual (CSA Technical Authority)	Canadian Space Agency (CSA)
Andrew Yau	University of Calgary
Robert Rankin	University of Alberta
William Ward	University of New Brunswick
Hans De Sterck	University of Waterloo
Ljubomir Nikolic	Natural Resources Canada (NRCan)
Konstantin Kabin	Royal Military College (RMC)
Hugh Podmore	Honeywell
Jose Arnal	University of Toronto
Leonid Olifer	University of Alberta

Planetary Space Environment Topical Team

Elements considered in consultation process:

- Strong heritage in cross-cutting instrumentation and measurements
- Additional experience in advanced data analysis and modelling based on observational data
- Several key new space exploration programs and mission opportunities have arisen since last consultation process:
  Lunar Gateway, NASA Artemis Program, NASA New Frontiers,
  NASA Mars Explorer, ESA Voyage 2050, ESA Terrae Novae
- Planning to go out beyond 2040+; however, there are several near-term opportunities

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Current Status:

- Summary of draft TT report was presented to the DASP community for feedback at last year's DASP Workshop in February 20-24, 2023.
- Draft report distributed to the DASP and solar and terrestrial science communities for feedback on April 3, 2023.
- Final version of the TT report was submitted to the CSA on June 16, 2023.
- CSA Canadian Space Exploration Final Report review meeting was held on February 12, 2024.
- Final feedback from TT leaders to CSA by February 23, 2024, including input to executive summary.

Planetary Space Environment Topical Team

Highest Prioritised Science Objectives	**Intent/Rationale**
Lunar Gateway: characterization of the radiation environment at Lunar Gateway and in deep space, using, e.g., Sweeping Energetic Particle Telescope (SWEPT). Develop models for capturing observed behaviour for now-casting of gateway radiation environment.	Would improve understanding of a new and dangerous environment to help ensure astronaut health. SWEPT technology currently under development with CSA funding, although launch date is still uncertain. Strong potential for collaboration with Astronaut Health Topical Team.
Lunar Gateway: characterize lunar atmosphere and plasma environment at Lunar Gateway (e.g., dusty plasmas, magnetic fields, electric fields, currents, etc.) via observations, modelling, and data analysis. Data sources such as dust monitors, NASA Heliophysics Environmental and Radiation Measurement Experiment Suite (HERMES), and ESA European Radiation Sensors Array (ERSA) payloads.	Would allow continuation of activities identified in previous Planetary Space Environment road map. Potential to make use of planned initial NASA HERMES and ESA ERSA instruments and observational capacity (e.g., opportunities for this includes Gateway Utilization Concept Studies). HERMES and ERSA will provide measurements of magnetic fields, ions, electrons and neutrons, lower energy and energetic particles from the Sun, galactic cosmic rays.

Planetary Space Environment Topical Team

Highest Prioritised Science Objectives	**Intent/Rationale**
Lunar Gateway: investigation of unsteady heliospheric and solar wind phenomena (i.e., CMEs, solar flares) affecting lunar and geospace environment for improved understanding of space weather. Would include theoretical studies and interpretation of Lunar Gateway observations (e.g., NASA HERMES, ESA ERSA), including eventual data assimilation of observational data into heliophysic and solar wind models for improved space weather now- and fore-casting.	Would provide unique and strategic opportunity to make use of data arising from planned initial NASA HERMES and ESA ERSA instruments and observational capacity of Lunar Gateway. Lunar Gateway will provide a unique opportunity to observe the plasma environment associated with both the solar wind near Earth/Moon system and within the magnetosphere of Earth (e.g., possible opportunities for this includes the CSA Co-Investigator).

Planetary Space Environment Topical Team

Intermediately Prioritised Science Objectives	**Intent/Rationale**
Lunar Surface/NASA Artemis: investigation of lunar atmosphere (e.g., dusty plasmas, magnetic fields, electric fields, currents, etc.) via observation, modelling, and data analysis supported by additional lunar surface observations and measurements.	Would allow continuation of activities identified in previous Planetary Space Environment road map. This activity would help prepare for instruments on the surface and would make use of data from such instruments, whether Canadian or international, in a later phase.
Mars/NASA Mars Life Explorer: investigation of evolution and history of Mars atmosphere (upper atmospheric winds, photochemistry, etc.) and ozone/water cycle.	There is significant Canadian instrument heritage (e.g. WINDII-type instruments). Applications include improved aero-braking of spacecraft. Potential for collaboration with Planetary Atmospheres Topical Team. Also has potential applications to Venus and outer planets.

Planetary Space Environment Topical Team

Intermediately Prioritised Science Objectives	**Intent/Rationale**
Lunar Surface/NASA Artemis: characterization of radiation environment on Lunar Surface using, e.g., Sweeping Energetic Particle Telescope (SWEPT). This again would be supported by model devlopment for now-casting of the lunar surface radiation environment.	Would improve understanding of a new and dangerous environment to help ensure astronaut health and complement measurements made at Lunar Gateway.

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Lower Prioritised Science Objectives	Intent/Rationale
Lunar Gateway: Observation of global aurora at Earth to understand terrestrial space weather processes and geospace environment.	Canada has significant expertise in designing and building auroral imagers. Potential for collaboration with CSA Space Utilization branch.
Exoplanets: exploration and new understanding of the atmospheric and space environment of exoplanets through observation (e.g., optical signatures of aurora in exoplanet atmospheres) and modelling.	Application to identification of potential bio-signatures of exoplanets. Potential for collaboration with both Exoplanet and Planetary Atmospheres Topical Teams.
Small Bodies & Dwarf Planets: gain understanding of the dusty plasma environment of a new comet.	Provides insight into the origins of the solar system.