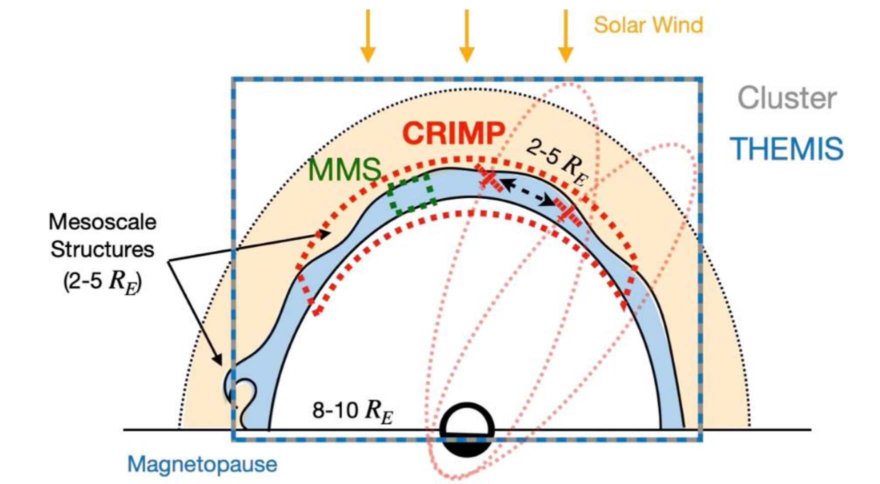
Compression and Reconnection Investigations of the MagnetoPause (CRIMP) — An Early Career SWMI Mission Concept

Jason Beedle (UNH), Frances Staples (UCLA), Michael Starkey (SwRI), Brett McCuen (Aerospace Corp.), Kelly Cantwell (Dartmouth), Bryan Cline (UIUC), Julie Rolla (JPL), Samuel Badman (Harvard-Smithsonian Astro.), Humberto Caldelas (MIT), Christian Hofmann (MIT), Alex Hoffmann (NASA Goddard), India Jackson (GSU), Tre'Shunda James (NASA Goddard), Miguel Martínez Ledesma (NASA Goddard), Bruno Mattos (USU), Sophie Phillips (ASU), Bryan Reynolds (Remcom Inc), Orlando Romeo (UC Berkely), Alfred Edward Nash III (JPL), Andrew Romero-Wolf (JPL), and Olga P Verkhoglyadova (JPL)

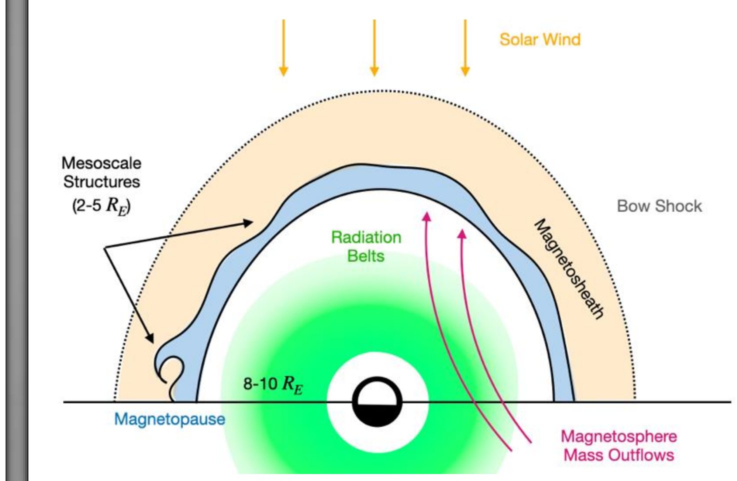
Introduction:

The Compression and Reconnection Investigations of the Magnetopause (CRIMP) mission is a Heliophysics Midex A/O targeted concept mission designed through the 2024 Heliophysics Mission Design School at JPL to study mesoscale structures and particle outflow along Earth's magnetopause. CRIMP targets SWMI science goals 1 and 2:

- **SWMI-1**: Establish how **magnetic reconnection** is triggered and how it evolves to drive mass, momentum, and energy transport.
- **SWMI-2**: Identify the **mechanisms** that control the **production**, **loss**, and **energization** of energetic particles in the magnetosphere.
- **CRIMP** is designed to be the first mission to probe mesoscale magnetopause structures with **in-situ, multi-point**, **contemporaneous** measurements.



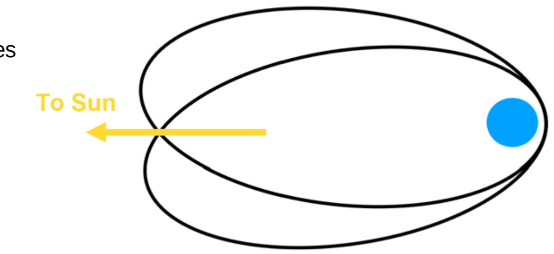
Motivation:



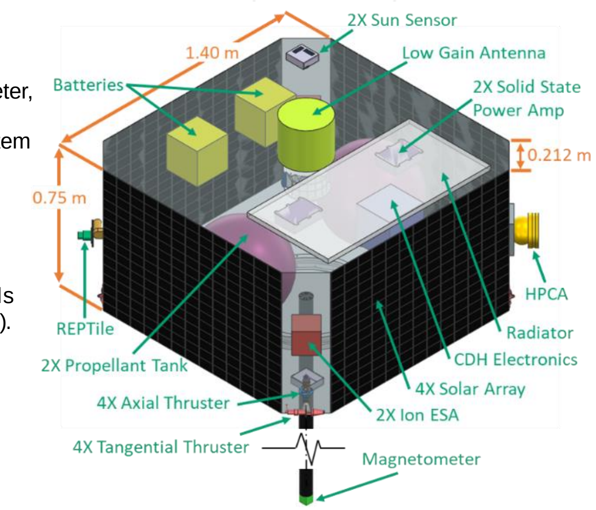
- Space weather energy transfers can result in energetic particles that damage important space-based and terrestrial assets.
- The magnetopause is the boundary between the solar wind and magnetosphere.
- Magnetospheric magnetic reconnection drives the energy transfer.
- Predicting this energy transfer requires understanding the processes involved at the mesoscale (2-5 R_E).

Mission and Spacecraft Design:

- **Mission Duration**: 2 years
- Two identical spacecraft in two orbital lobes
- ESPA ring deployment

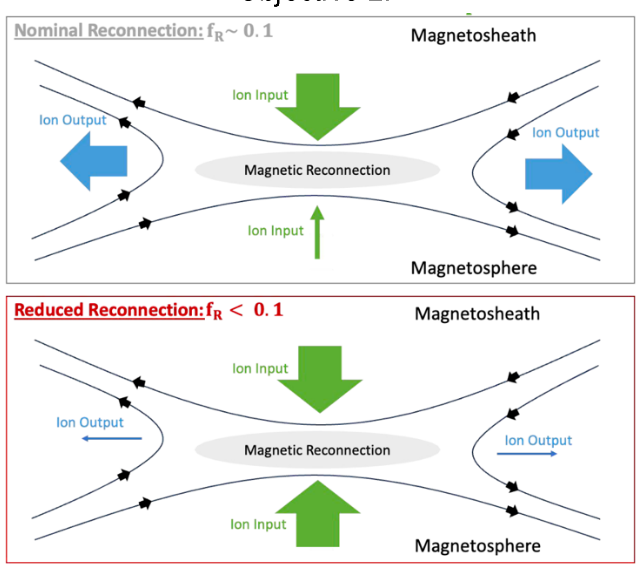


- **Nominal Orbital Configuration:**
  - Periapsis: 1.3 R_E
  - Apoapsis: 15 R_E
  - Inclination (relative to ecliptic): 22°
  - Lobe AOP separation: 15°
  - Spacecraft in-phase
- **Spacecraft Design**
  - **Dry/Wet mass**: 282/343 kg
  - **Spin-stabilized**: 15 rpm rotation rate
  - **ADCS**: Sun sensors, IMU, Magnetometer, Magnetorquers
  - **Propulsion**: Hydrazine blowdown system (orbital maneuvering and spin control)
  - **C&DH**: Sphynx processor, 128 GB of storage
  - **Communications**: X-band, Low-gain antenna, Near Space Network
  - **Power**: GaAs TJ Rigid Cell solar panels (2.8 m^2) and Li-Ion batteries (1094 Wh). Max. power required = 174 W
  - **Thermal**: Cold-biased, radiator and louvers for heat rejection control
  - **Mechanical**: Magnetometer on deployable boom, REPTile on scan platform



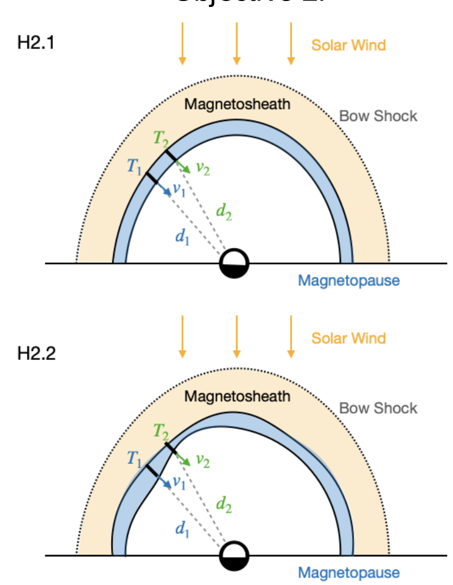
Science:

Objective 1:



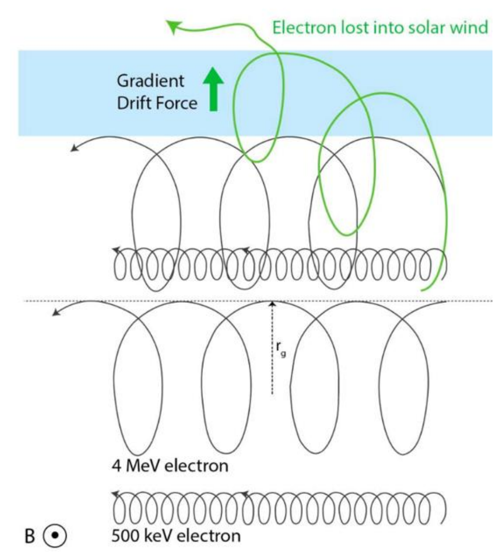
- **Uncover** how local mass density enhancements affect the global reconnection rate.

Objective 2:



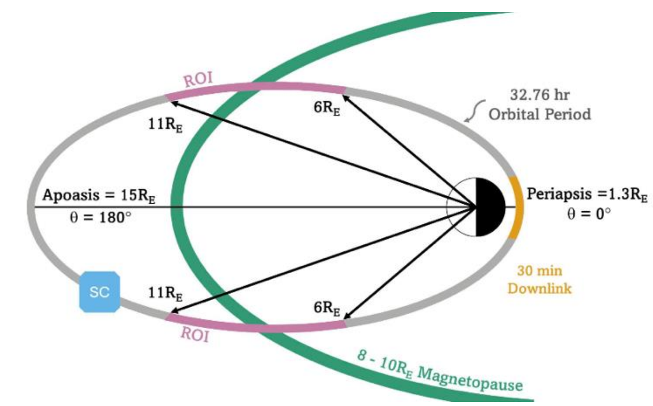
- **Find** how mesoscale structures drive magnetopause dynamics.

Objective 3:



- **Discover** if the magnetopause acts as a perfectly absorbing boundary for radiation belt electrons.

Science Mission Profile:



- **Spacecraft instrumentation**:
  - 1 Hot Plasma Composition Analyzer (HPCA) - MMS Heritage
  - 2 Ion Electrostatic Analyzers (ESA) - THEMIS Heritage
  - 1 Solid State Telescope (REPtile) - Van Allen Heritage
  - 1 Magnetometer - THEMIS Heritage
- Spacecraft flown in highly elliptical orbits, each in their own lobe, to capture mesoscale structures and outflows along the magnetopause. 0.34 Gbits/orbit/spacecraft of data generated.
- Region of Interest (ROI) centered on nominal to compressed magnetopause position: 6 to 11 R_E on the dayside.

HMDS:

This mission concept was designed through the 2024 Heliophysics Mission Design School (HMDS).

HMDS is sponsored by NASA's Heliophysics Division and is managed by JPL, California Institute of Technology. Scan the QR code above to learn more.

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