Ion Mass Spectrum Analyzer (IMSA) for The SCOPE Mission

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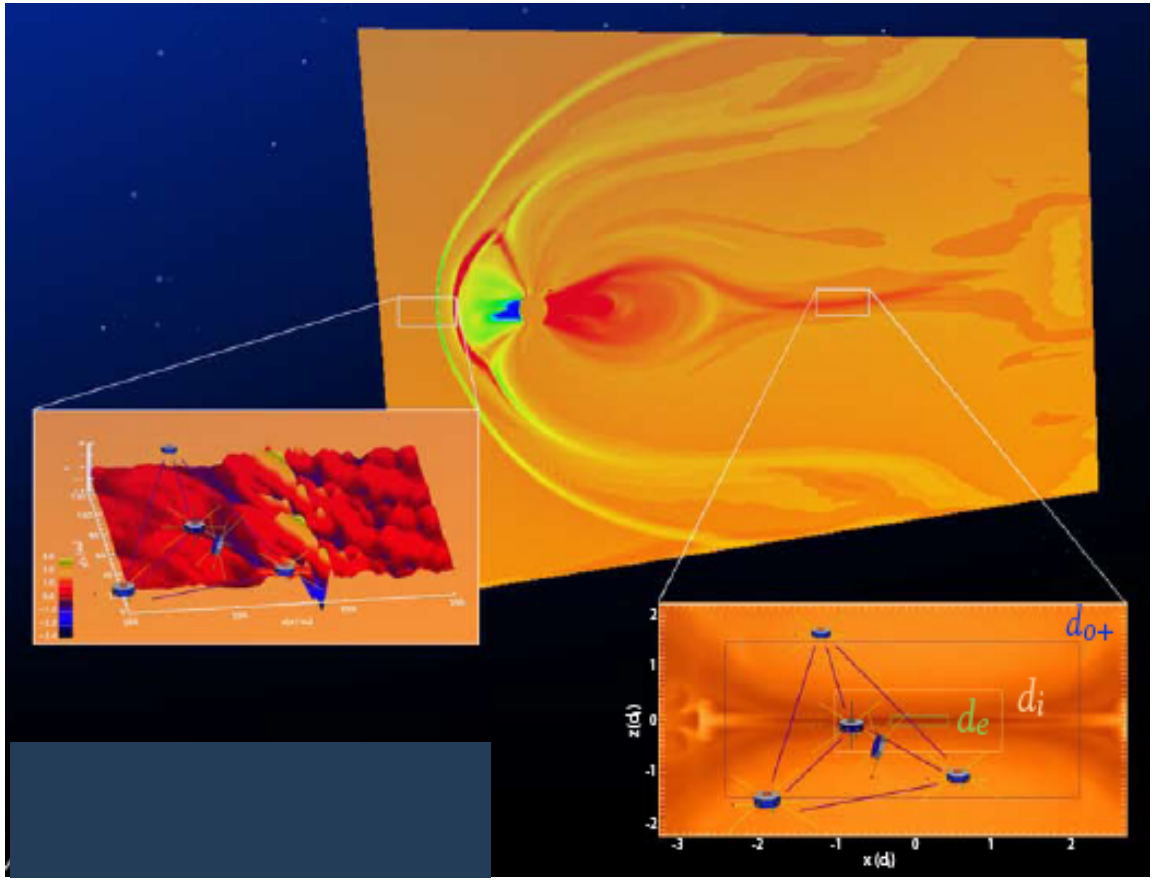
The SCOPE Mission

The SCOPE Mission is a JAXA-led mission to study cross-scale coupling in fundamental physical processes.

Primary Science Objectives:

- How do collisionless shocks accelerate and thermalize particles
- How do cross-scale processes affect reconnection dynamics.

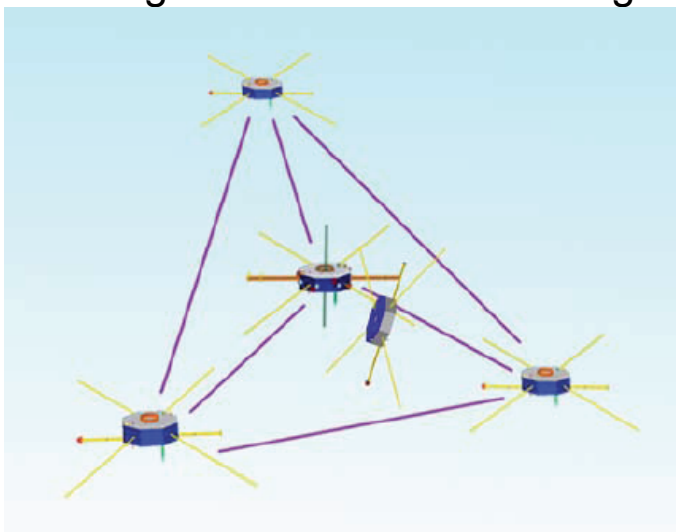


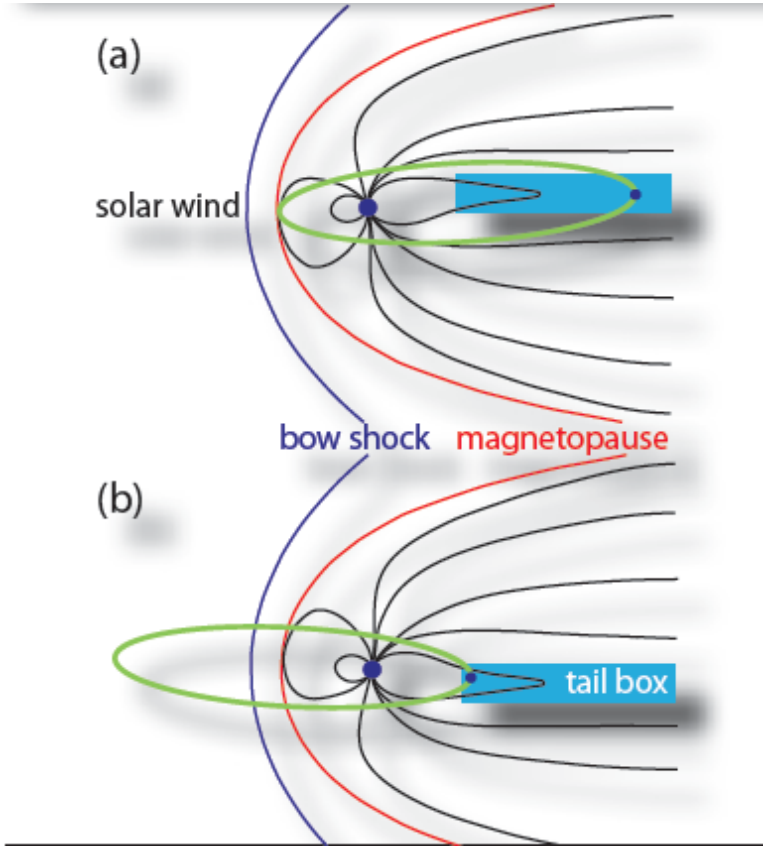
The SCOPE Mission

Mission Strategy:

Fleet of 5 spacecraft

- Mother/daughter pair, separated by ~ 10 km
- 3 far-daughters, separated by distances varying from 100-5000 km.
- Orbit optimized to visit the key regions: Bow shock, magnetopause, and magnetotail reconnection region.





The SCOPE Mission

Instrumentation:

- Mother ship is comprehensively instrumented, providing full particle and field measurements over wide energy range, including ion composition from 10 eV/q to 180 keV/q
- Near-daughter will provide high res field measurements, and the spin is oriented 90 degrees from the mother spacecraft to optimize the high resolution 3D electric field measurements
- 3 far daughters provide ion and fluid-scale particle and field measurements

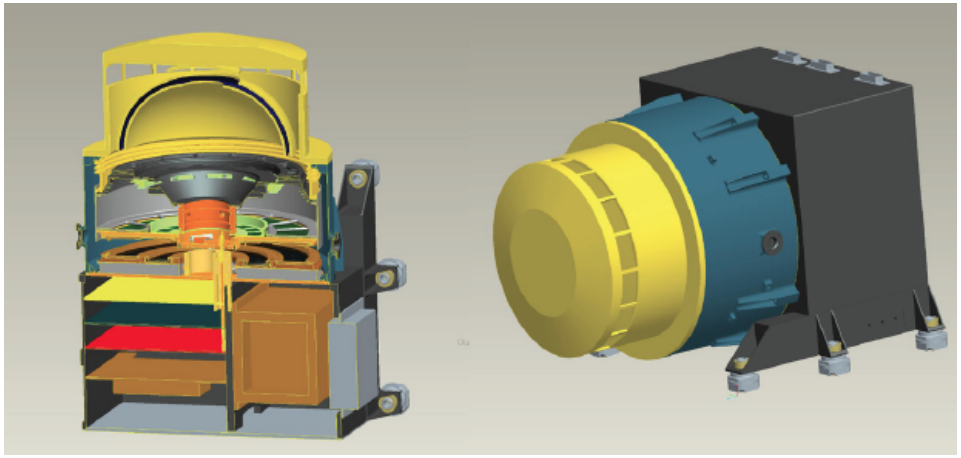
SCOPE SCIENCE INSTRUMENTS			
	MOTHER	**DAUGHTER [near:1]**	**DAUGHTER [far:3]**
Electron	FESA (10 eV – 30 keV High Time Res.) MESA (10 keV – 60 keV) HEP-ele (30 keV - 800 keV)	N.A.	EISA (10 eV–20 keV/q) Electron and ion measurement
Ion	FISA (5 eV/q – 30 keV/q High Time Res.) IMSA (10 eV/q – 40 keV/q Mass) MIMS (10 keV/q – 180 keV/q Mass) HEP-ion (160 keV – 2 MeV)		
Particle & Field	O-WPIA (One-chip Wave Particle Interaction Analyzer)	N.A	N.A
Magnetic Field	MGF (DC – Low Freq. Mag. < 128 Hz) OFA/WFC-B (f < 20 kHz)		
Electric Field	EFD (DC ~ 64 Hz) OFA/WFC-E (f < 100 kHz) HFR (f < 10 MHz)		

The Ion Mass Spectrum Analyzer

The contribution of this Mission of Opportunity is the Ion Mass Spectrum Analyzer for the mother ship:

- Time-of-flight mass spectrometer, based on heritage designs from Cluster/CODIF, FAST/TEAMS, and STEREO/PLASTIC
- Separates key magnetospheric species, H+, He+, and O+, plus the solar wind H+ and He ++ over the energy range 10 eV/e-40 keV/e

IMSA Characteristics	
Instrument Type	ESA (E/Q) - TOF - Ion Mass Spectrometer
Detectors	MCPs
Species	H^+, He^{++}, He^+, O^+
Energy Range	10 eV/e - 40 keV/e
FOV (instantaneous)	10 x 360
GF (Flux Reducer OFF)	2.32E-3 cm^2-sr-eV/eV
GF (Flux Reducer ON)	2.32E-5 cm^2-sr-eV/eV
dE/E	13%
M/Q/d(M/Q)	> 8
Angular Resolution	22.5° x 22.5°
Time Resolution	1.5 s max



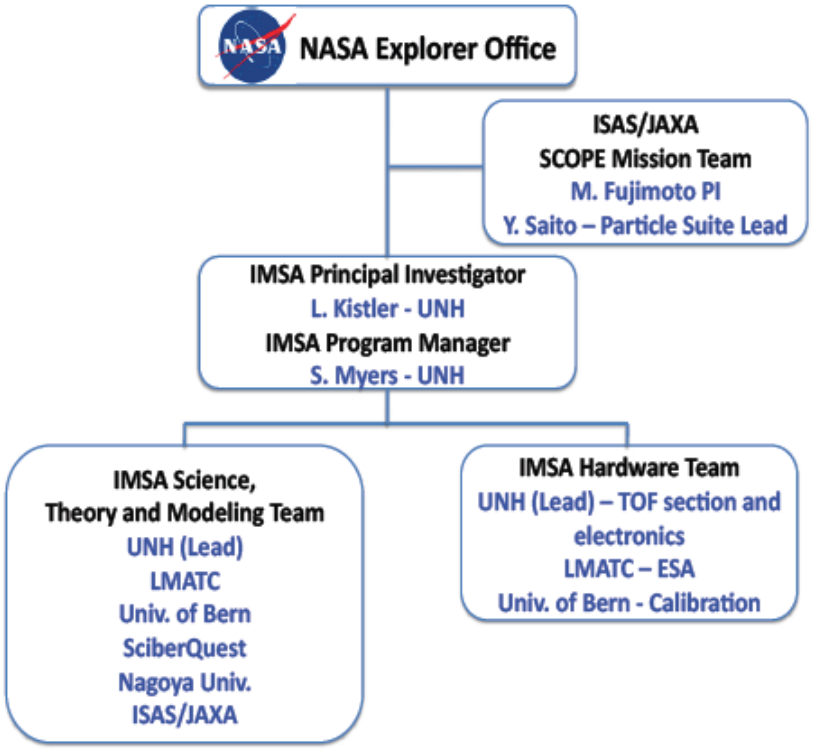
IMSA Team

Hardware contributions

- UNH - overall lead, time-of-flight section and electronics
- LMATC - ESA and associated electronics
- University of Bern - Calibration facilities

Theory and Modeling

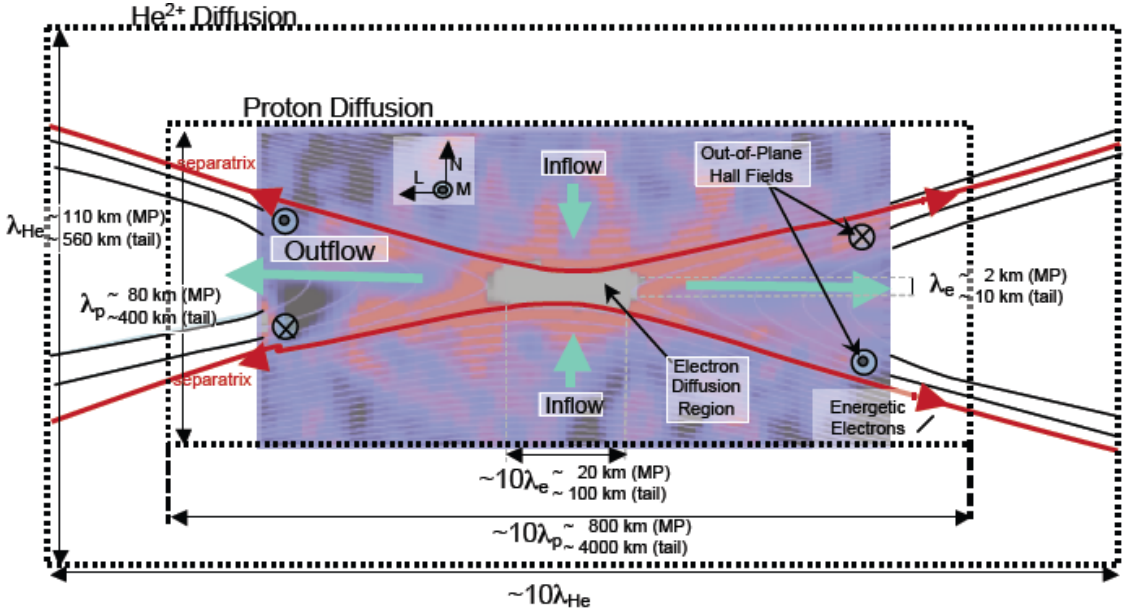
- UNH - 2-fluid “Magnetic Reconnection Code (MRC) and “Particle Simulation Code (PSC), plus analytical theory.
- SciberQuest/UCSD -”H3D” hybrid code and particle-in-cell “VPIC” code, plus data-mining capabilities.
- Nagoya - Structure reconstruction techniques.



Contributions of IMSA

The Ion Mass Spectrum Analyzer is a critical part of the SCOPE payload:

- Ion composition is critical to determining the plasma parameters relevant to cross-scale physics (e.g. Alfven speed, deHoffman teller frame)
- Heavy ions can be be used as test particles, giving a different scale to probe acceleration and transport processes
- In some cases, the heavy ions dramatically change the structure of the region, either adding a larger scale or changing the topology



Summary

- This Mission of Opportunity is an opportunity for the US to be involved in an exciting new international mission.
- The SCOPE mission is the next step in our understanding fundamental physical processes - it will build on the knowledge from Cluster (ion scale) and MMS (electron scale) to illuminate the cross-scale physics.
- The IMSA provides a critical component of this mission, providing the heavy ion measurements on the mother ship.