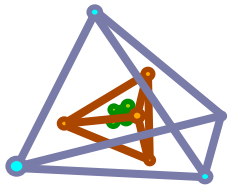


Cross-Scale

Cross-Scale: multi-scale coupling in space plasmas

S. Schwartz, C. P. Escoubet and
the Cross-Scale Science Study Team

Cross-Scale Science

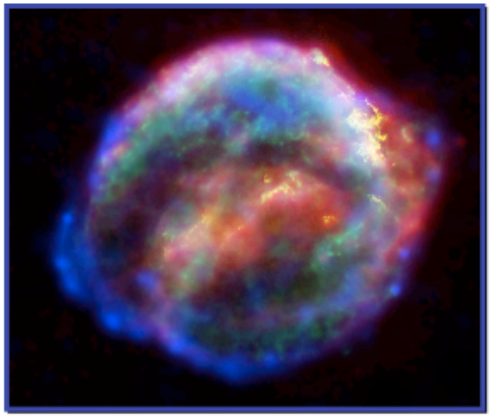
3 universal phenomena control plasmas

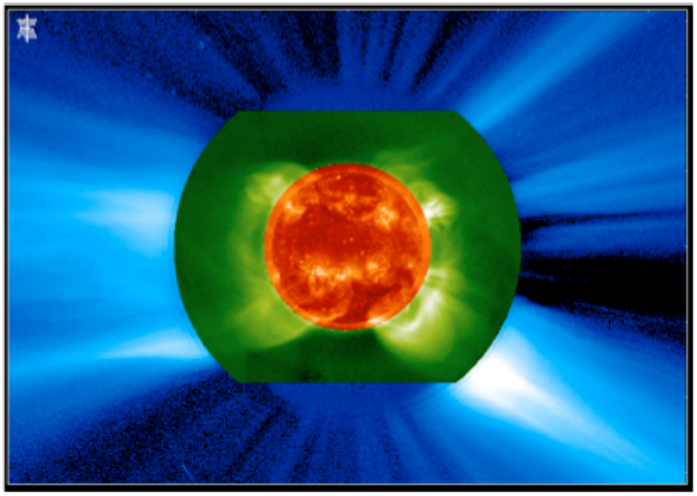
- Shocks
- Reconnection
- Turbulence

Responsible for

- Particle acceleration
- Energy and momentum exchange
- Transport

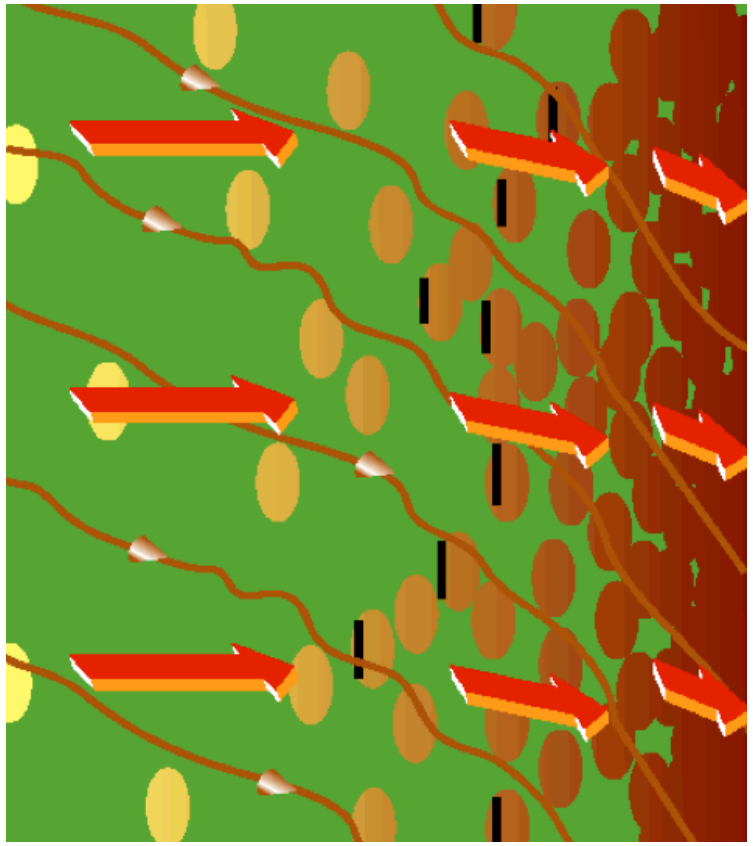
in astrophysical and laboratory plasmas





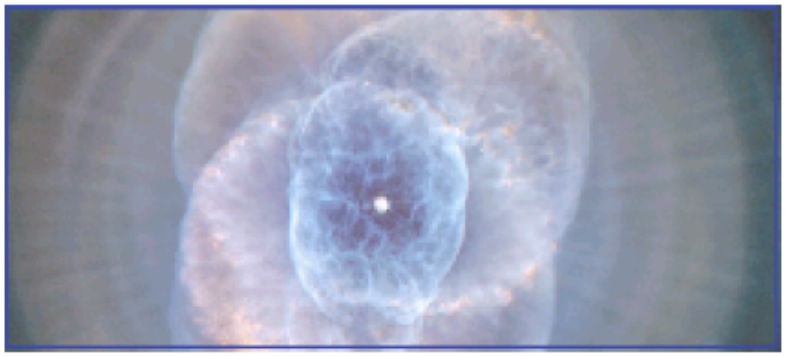
Observational Challenges

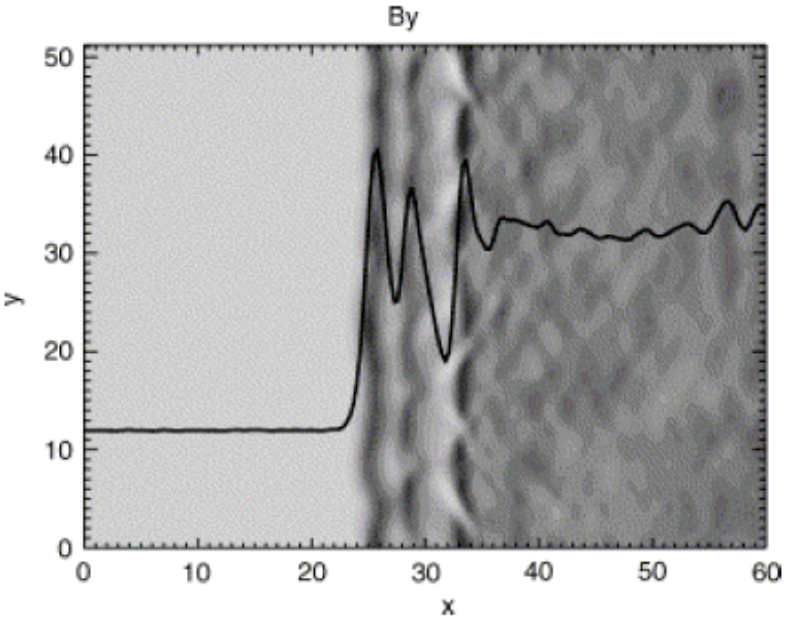
- Time-varying
- Fundamentally 3D
- 3 spatial & temporal scales
  - electron
  - ion
  - fluid
- Nonlinearly coupled
- Collisionless ⇒ Kinetic
- Plasma ⇔ EM fields
- Can’t sample distant astro-plasmas



How does the Solar System Work?

- How do shocks accelerate and heat particles?
  - Acceleration?
  - Energy partition?
  - Variability?





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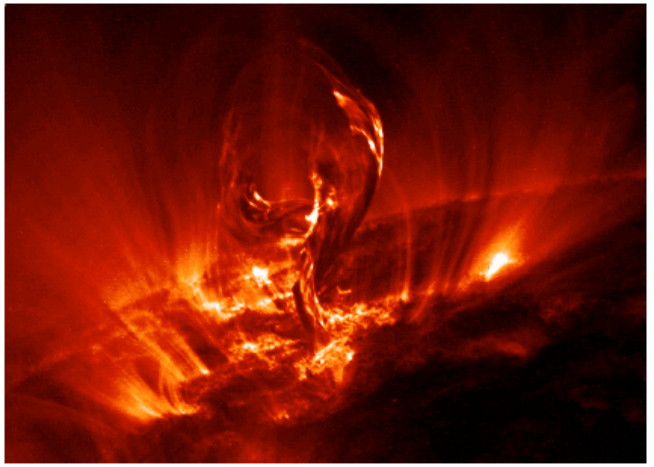

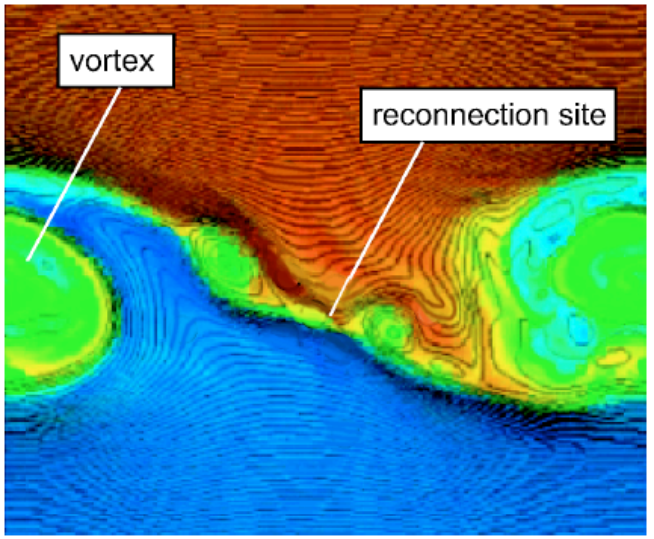

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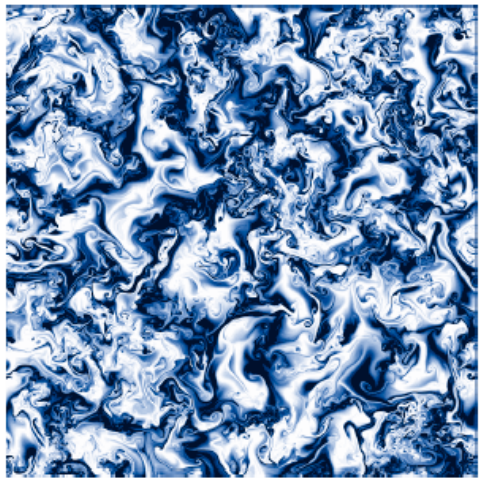
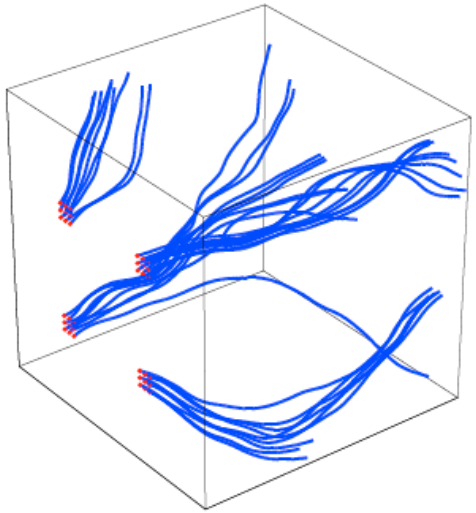
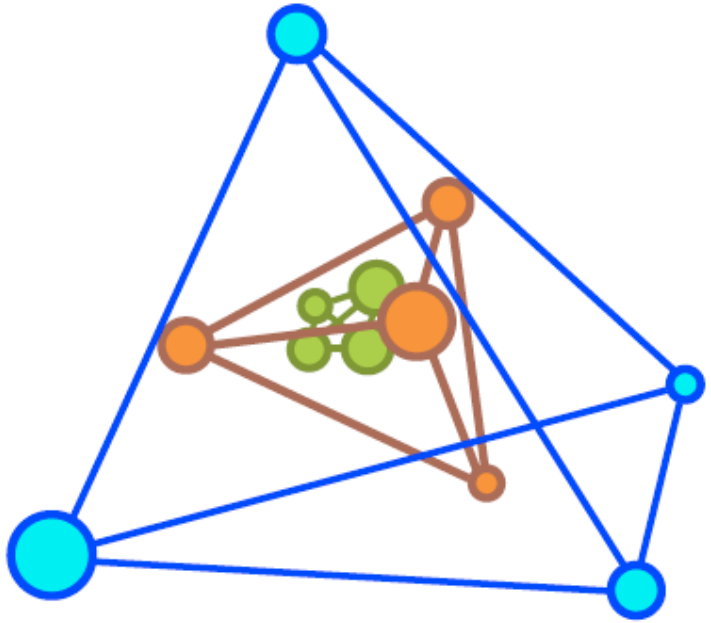
- How does turbulence control transport in plasmas?
  - Energy cascade?
  - Anisotropies?
  - Coherent structures?





Mission requirements

- Key Concepts
  - ⟨Behaviour⟩ ≠ Behaviour of ⟨⟩
  - Simultaneous multi-scale
  - Near-Earth: unique in situ plasma laboratory
- Mission Design
  - Electron Scale: Comprehensive payload
  - Ion Scale: Targeted payload
  - Fluid Scale: Context payload
  - Focus: coupling between scales



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- Mission Design
  - Electron Scale: Comprehensive payload
  - Ion Scale: Targeted payload
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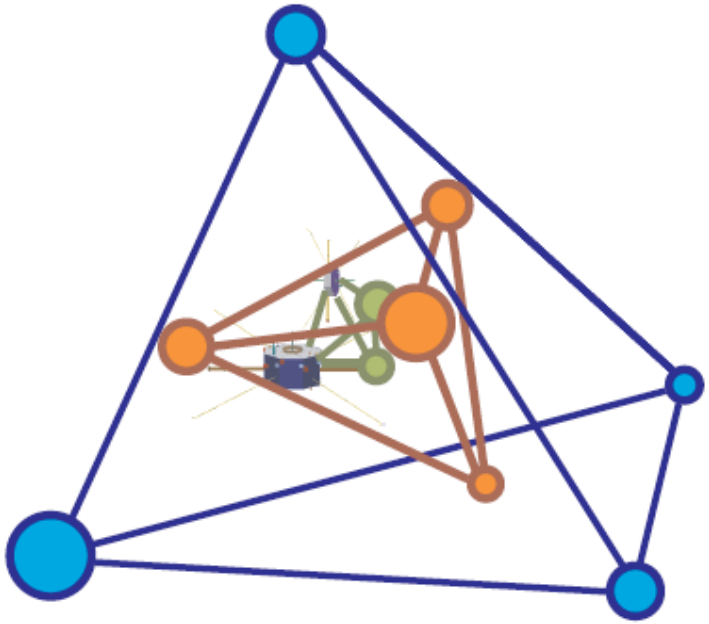
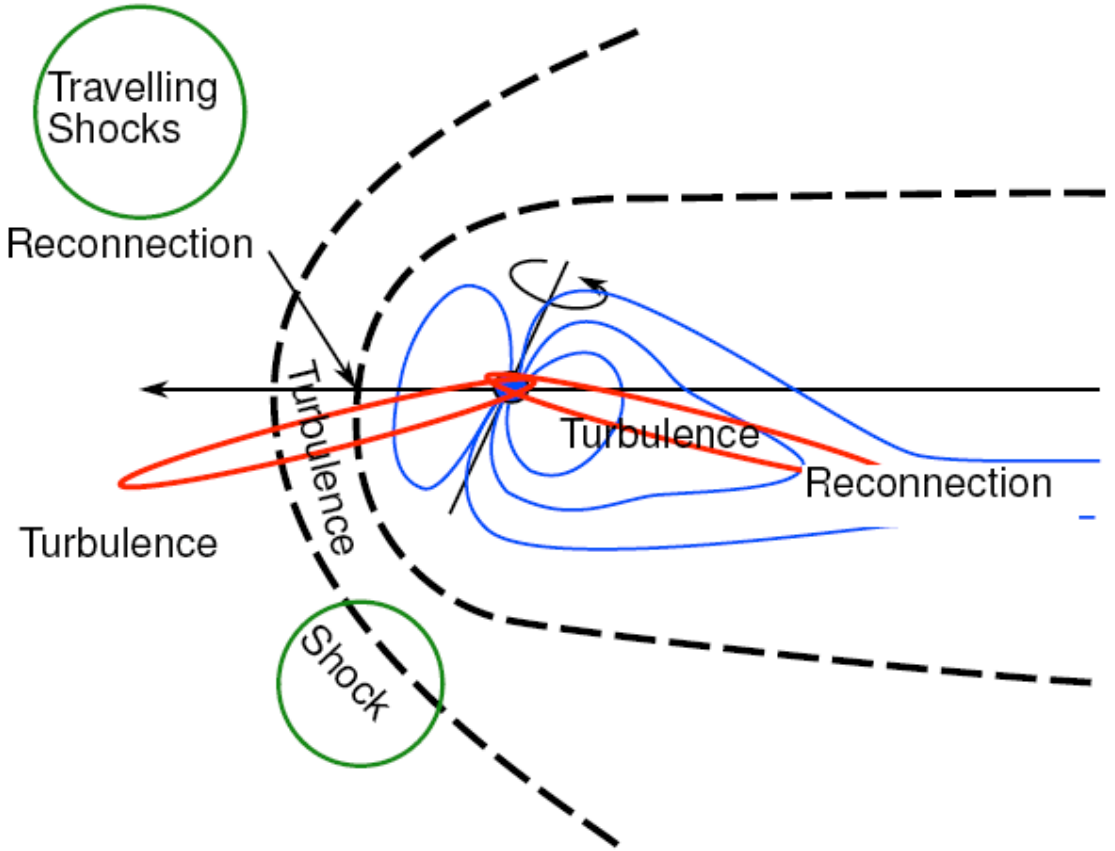
  - Focus: coupling between scales
  - Extensive payload at electron scale: JAXA SCOPE



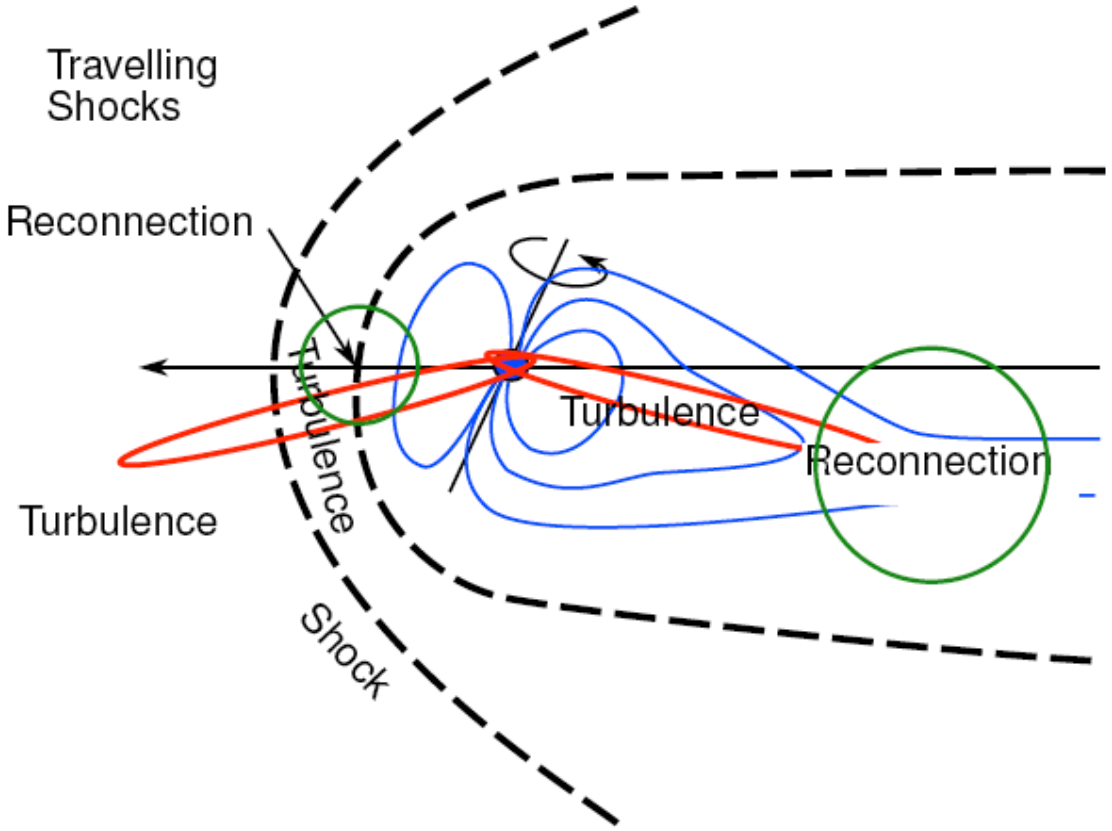
Orbit/Launch

- Near-Earth space contains
  - Shocks



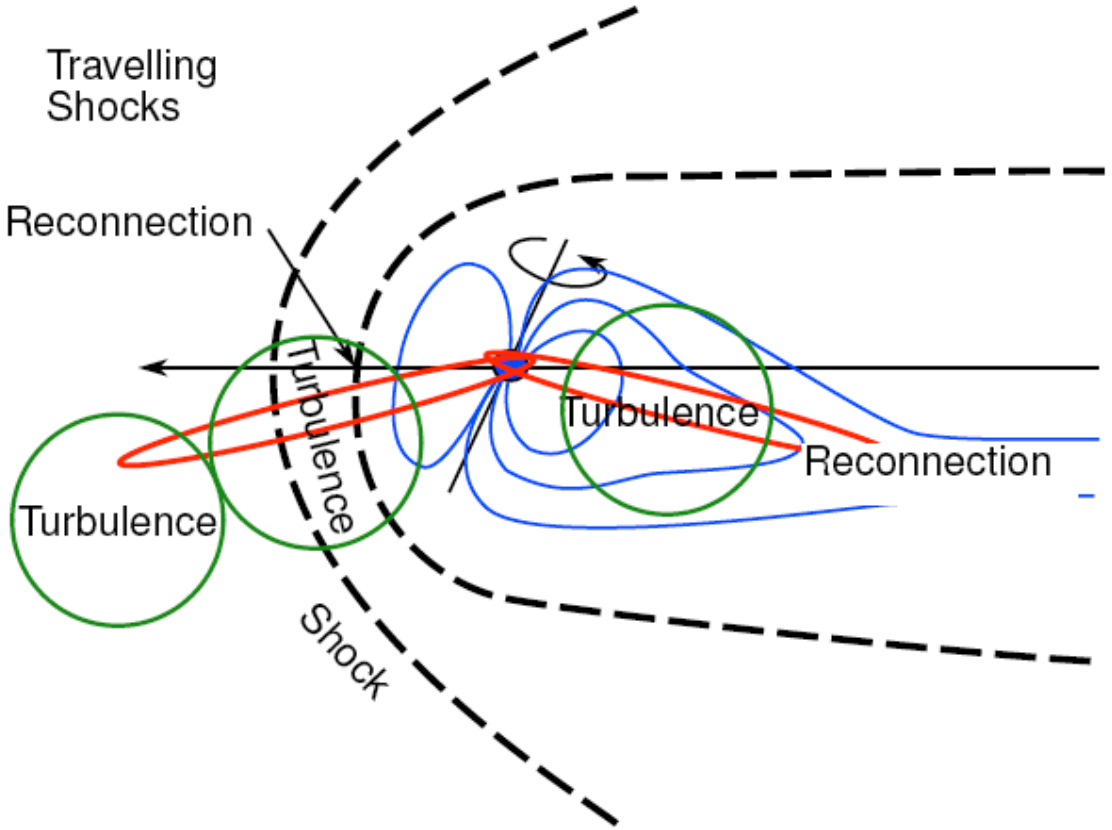
Orbit/Launch

- Near-Earth space contains
  - Shocks
  - Reconnection



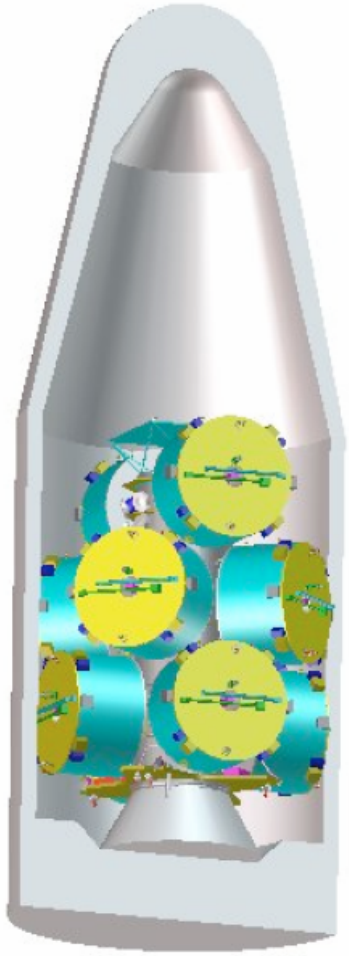
Orbit/Launch

- Near-Earth space contains
  - Shocks
  - Reconnection
  - Turbulence



Orbit/Launch

- Near-Earth space contains
  - Shocks
  - Reconnection
  - Turbulence
- Orbit: 10x25 Re (14 deg. inclination)
- Launch up to 7 s/c
- Separate SCOPE launch for 2 JAXA + NASA+CSA
- Extendable by other agencies



Possible payload distribution

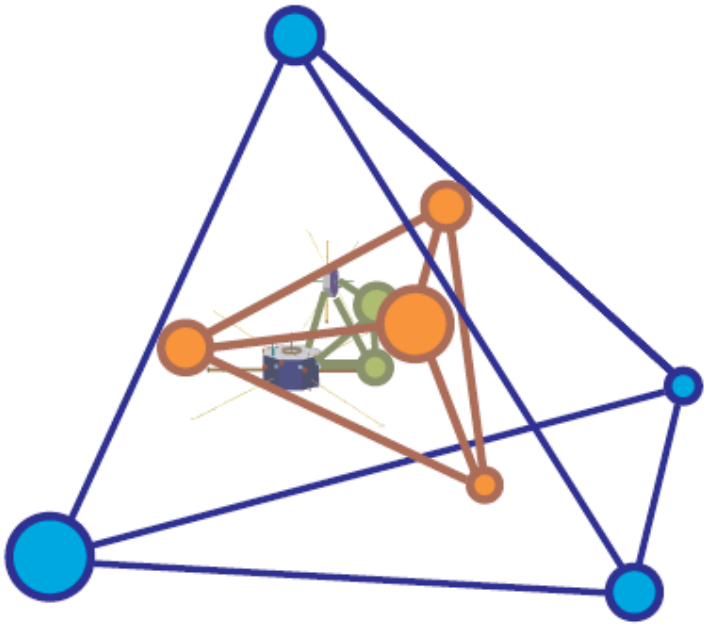
No	1		2		3				4		5		6		7	
Type of S/C	e1	#	e2	#	e3	#			i1/e4	#	i2	#	i3	#	i4	#
AC magnetometer	ACB	1	ACB	1	ACB	1			ACB	1	ACB	1	ACB	1	ACB	1
Potential control	ASP	1	ASP	1												
Electric field			E2D	4					E2D	4	E2D	4	E2D	4	E2D	4
Electric field	E2Dincl	4			E2Dincl	4										
Plasma sounder	EDEN	1	EDEN	1	EDEN	1			EDEN	1	EDEN	1	EDEN	1	EDEN	1
Electron sensor	EESA	4	EESA	4					EESA	2	EESA	2	EESA	2	EESA	2
Energetic particles									HEP	1			HEP	1		
Ion composition															ICA	1
Ion/electron sensor									IESA	2	IESA	4	IESA	2	IESA	2
DC magnetometer	MAG	1	MAG	1	MAG	1			MAG	1	MAG	1	MAG	1	MAG	1
Wave processor	ACDPU	1	ACDPU	1	ACDPU	1			ACDPU	1	ACDPU	1	ACDPU	1	ACDPU	1
Particle processor	CPP	1	CPP	1					CPP	1	CPP	1	CPP	1	CPP	1

Table 1: Payload composition per S/C in the seven S/C constellation case

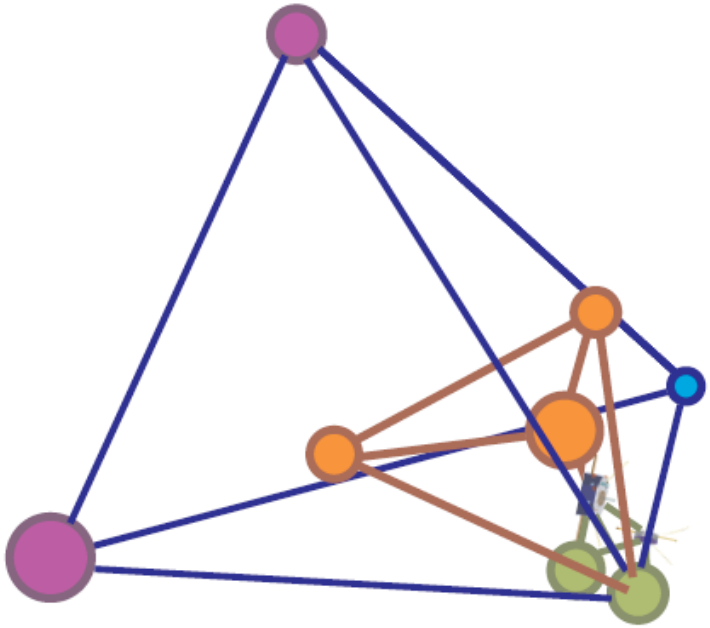
Key requirements (feasibility TBC):

- Limitation of payload instrument modes
- Autonomous instrument operation (also during eclipses, radiation belt, solar flare)
- Speedy initialization/recovery procedures (maximum 1 day)

Alternative configurations



Three tetrahedra
(12 spacecraft)



Shared corner
(10 spacecraft)

Industry study status

- Two industrial consortiums started study in Jul 08. End in Jun 09
- Trade-off phase finished
- Detailed architecture starting
- Down-selection in Autumn 09 (M-class)