# Self-Adaptive Magnetic reconnection Explorer (SAME)

Self-adjusted cross-scale measurement of space plasmas by a constellation of 12+ cubesats and 1 mother satellite
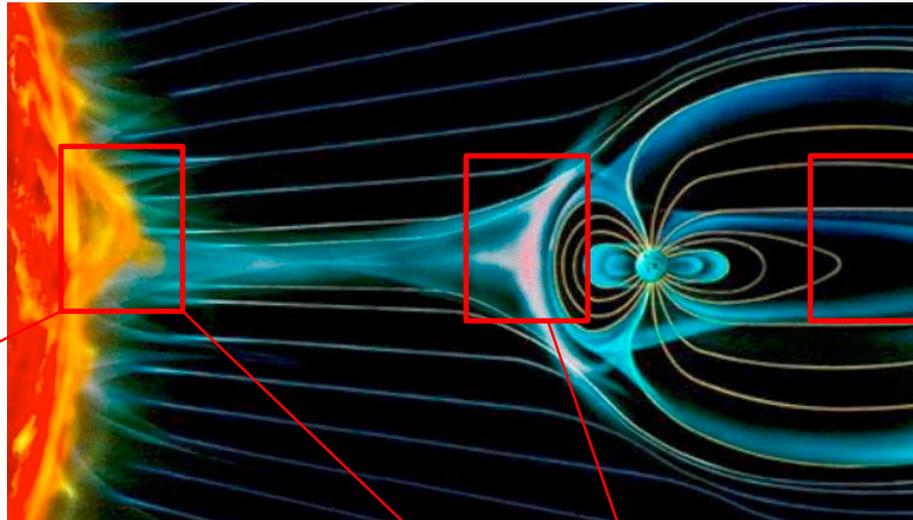
Lei Dai , NSSC, CAS

Motivation

Space Science Programs of Chinese Academic of Sciences,
(**Strategic Priority Program on Space Science II, Chinese Academy of Sciences**)
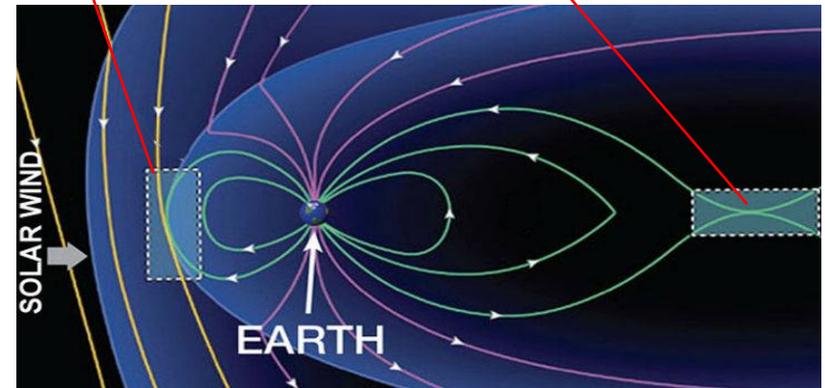Science opportunity to explore solar-terrestrial connection
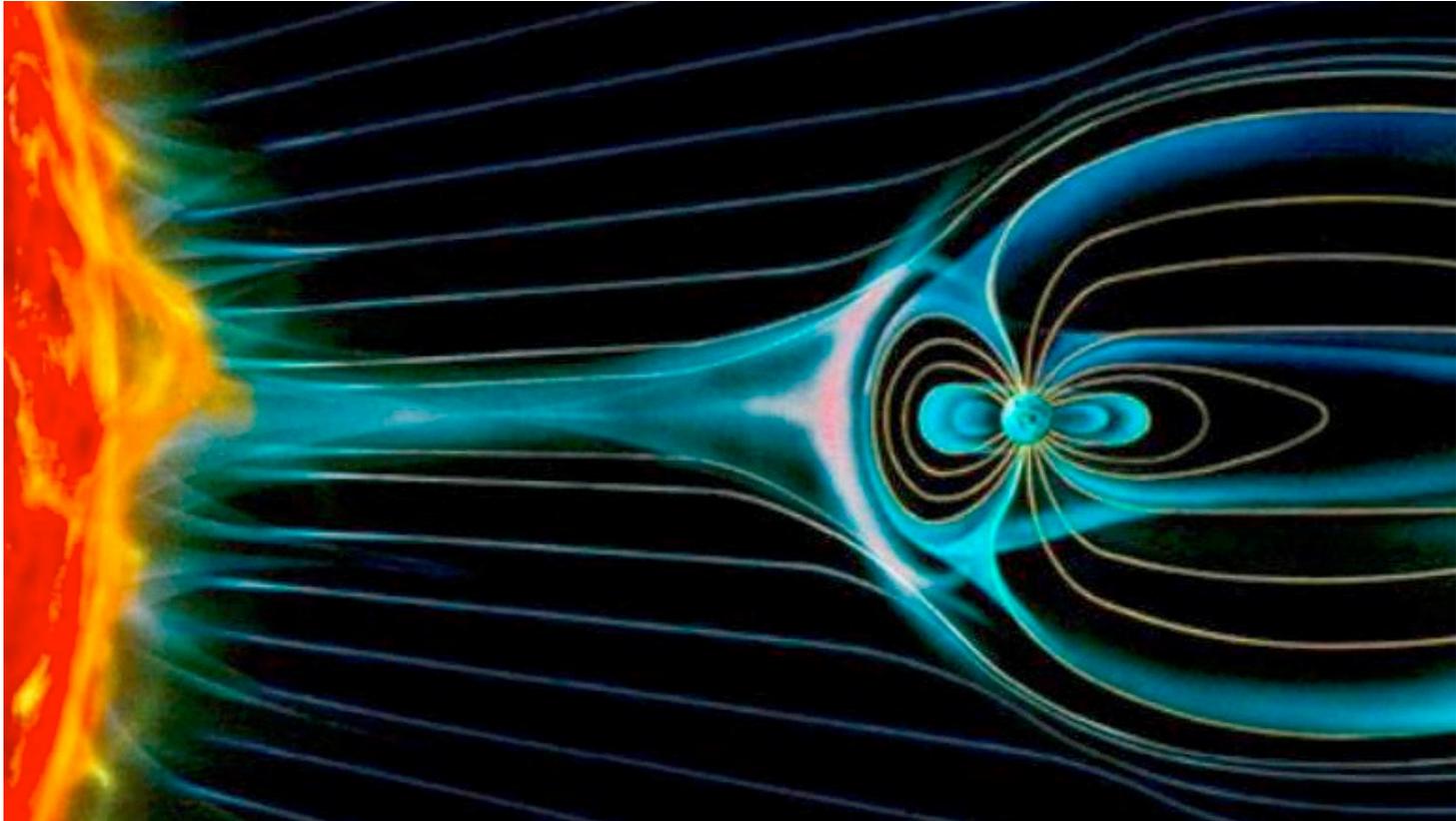
Motivation

Magnetic Reconnection: a fundamental and key process in the chain of the solar-terrestrial coupling

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Magnetic reconnection near the Sun:
A driver for energy transport in the chain of the solar-terrestrial coupling

Motivation

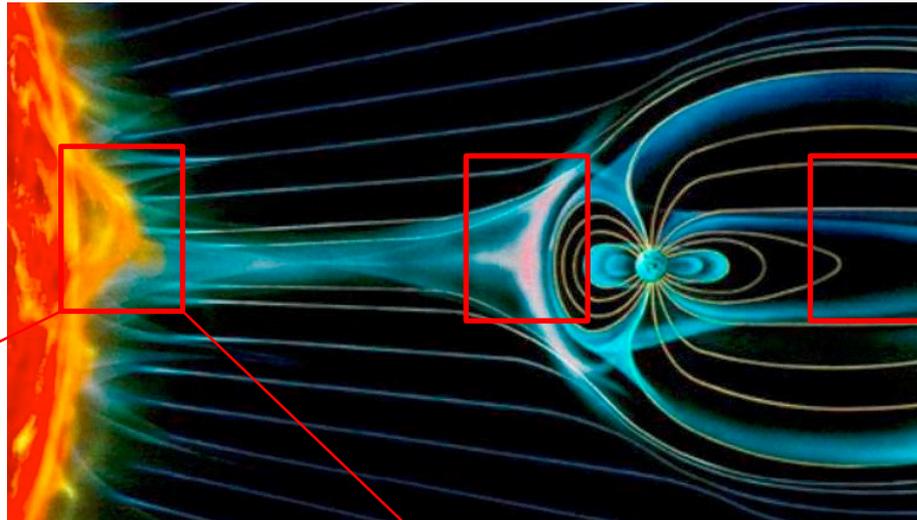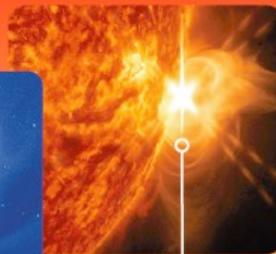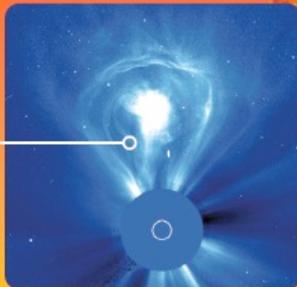Magnetic Reconnection: a fundamental and key process in the chain of the solar-terrestrial coupling

Magnetic reconnection near the Earth:
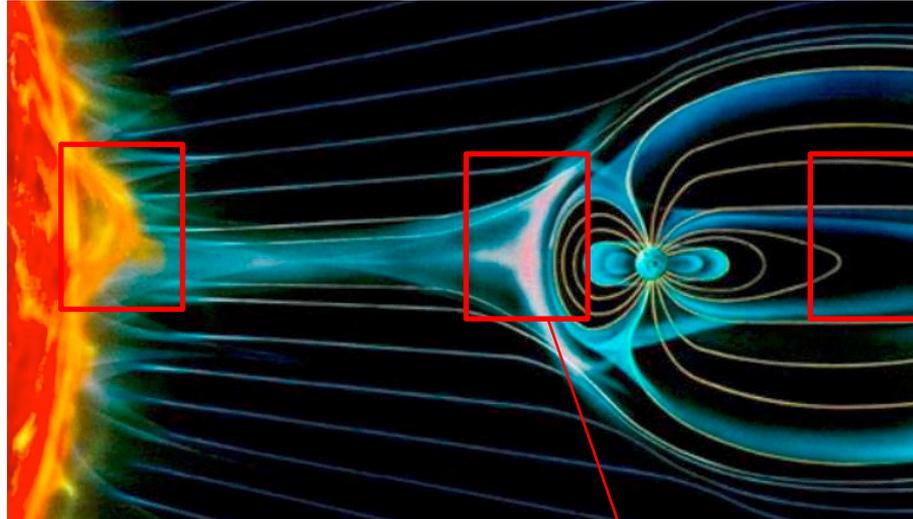1) Controls energy entry into the magnetosphere
2) Regulate energy release within the magnetosphere
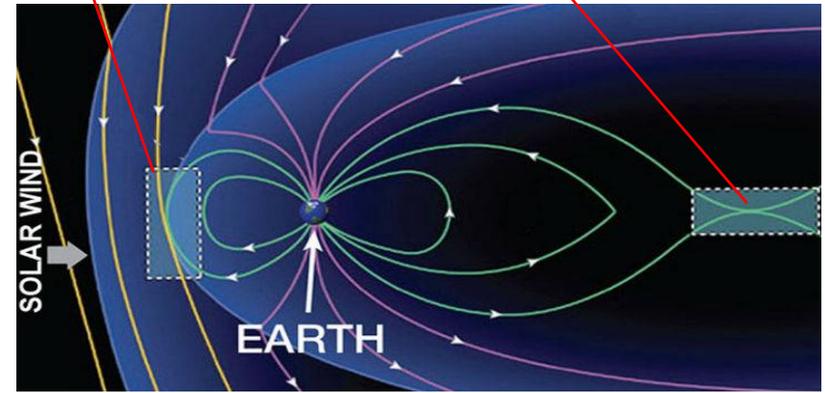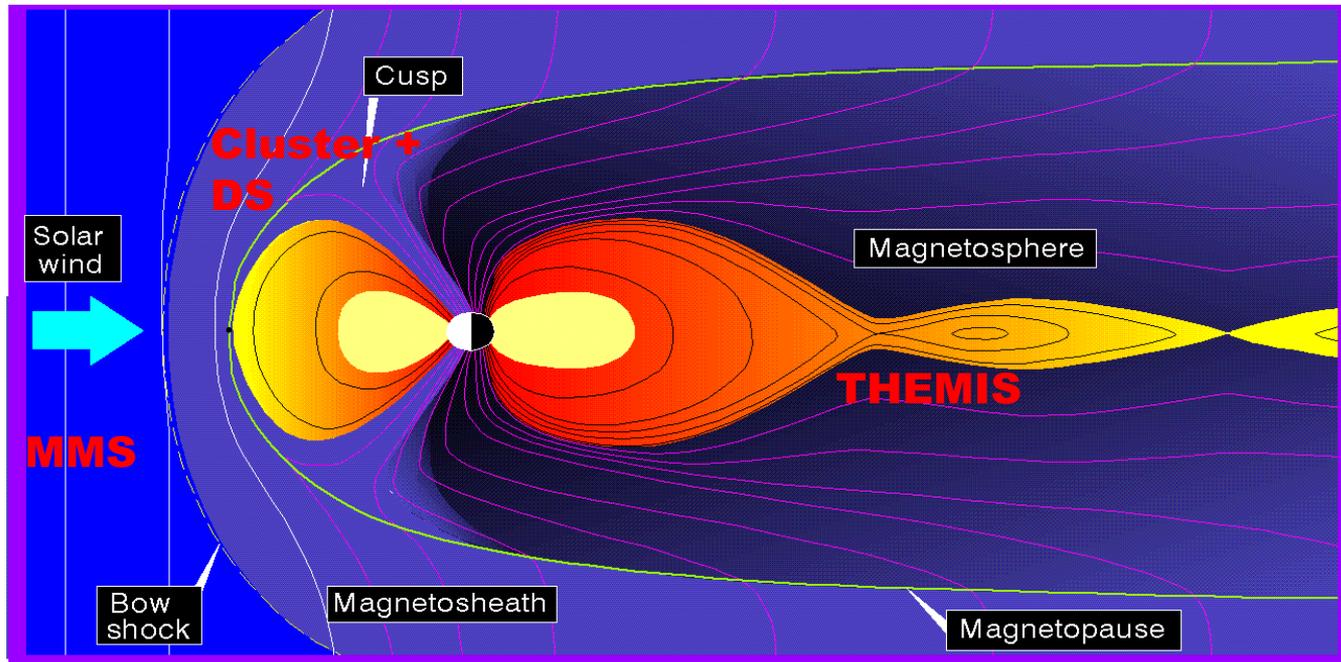
Magnetosphere is a natural laboratory for in-situ exploration of magnetic reconnection

In-situ constellation missions: MMS, Cluster+Double_star, THEMIS

As for now (2019), there is still no magnetosphere constellation mission planned for implementation in the future.
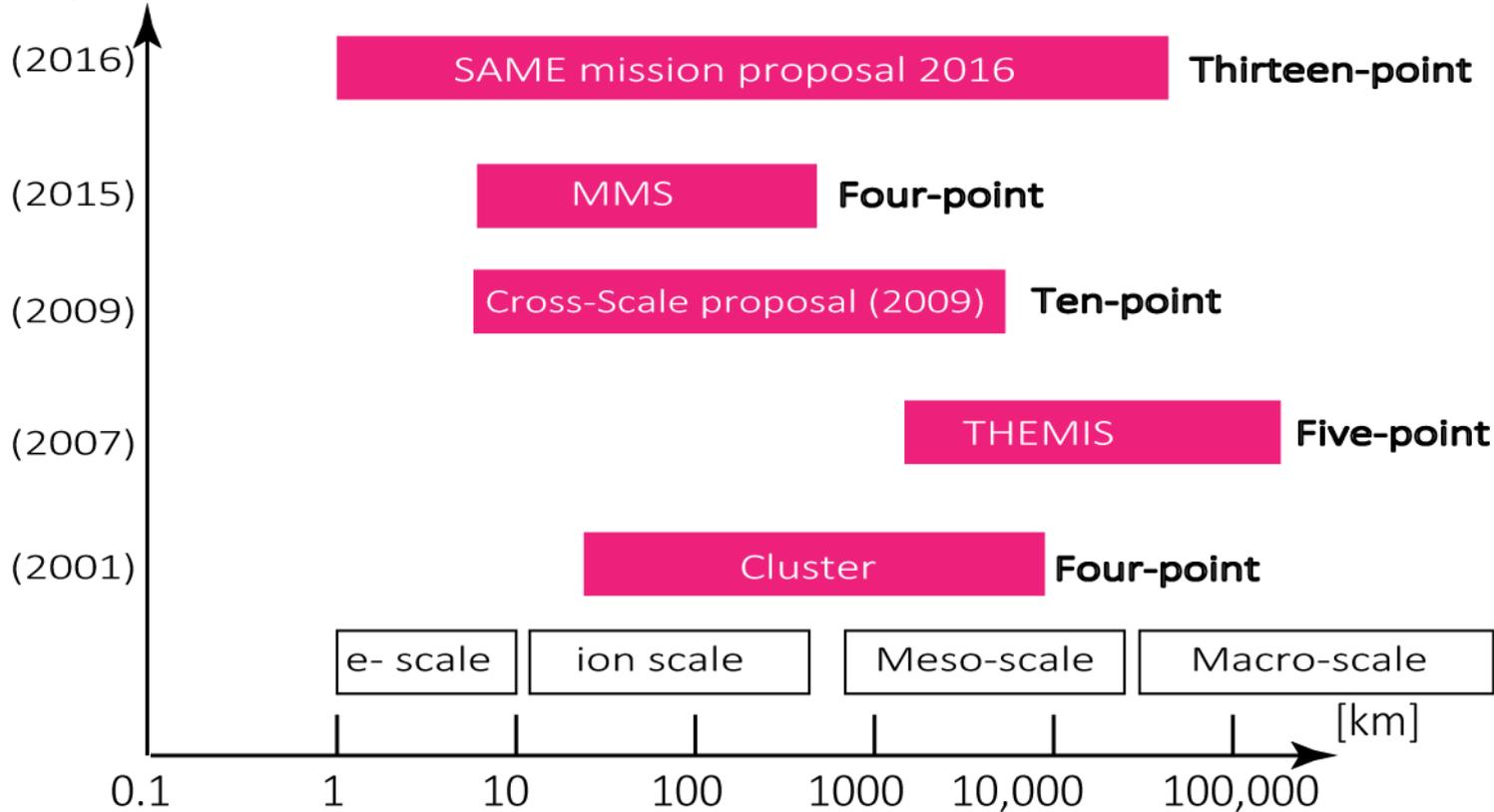
Mission profile：

1) Mother-satellite+12 small satellite。

2) Three (perhaps four?) set of small satellite

3) Each set includes four small satellite, with separation at the scales of 1-5km(electron scale)，100km (ion scale), and 10000km(Macro-scale), with the option to adjust the macro-scale separation to even larger scale.

4) Configuration (Self-Adjustable)
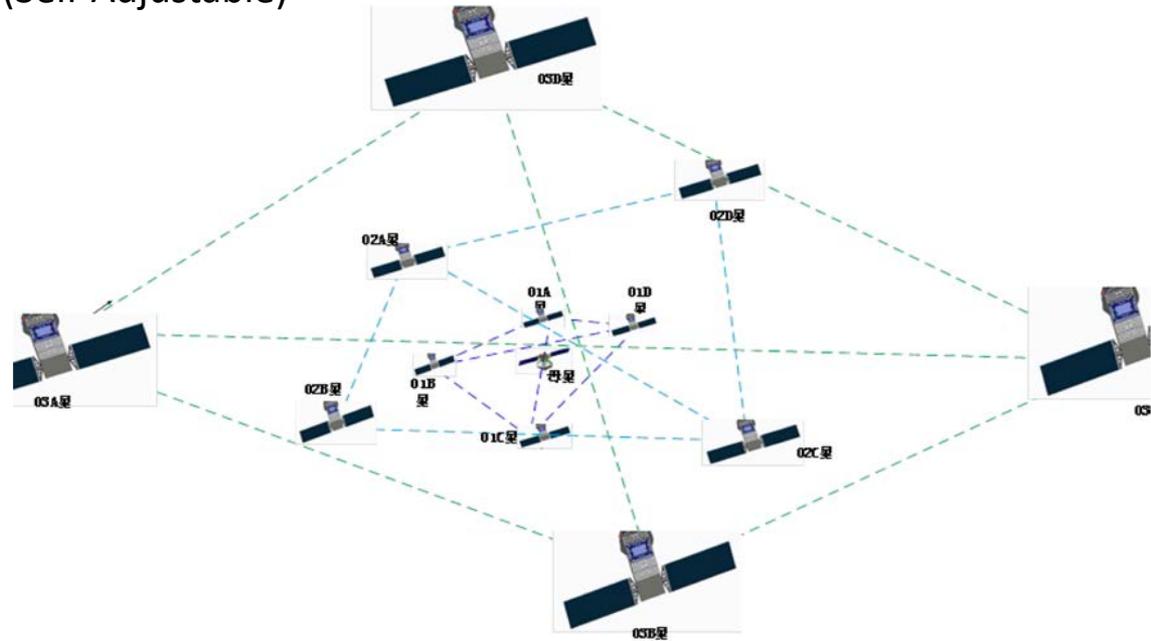
Mother-son Satellite
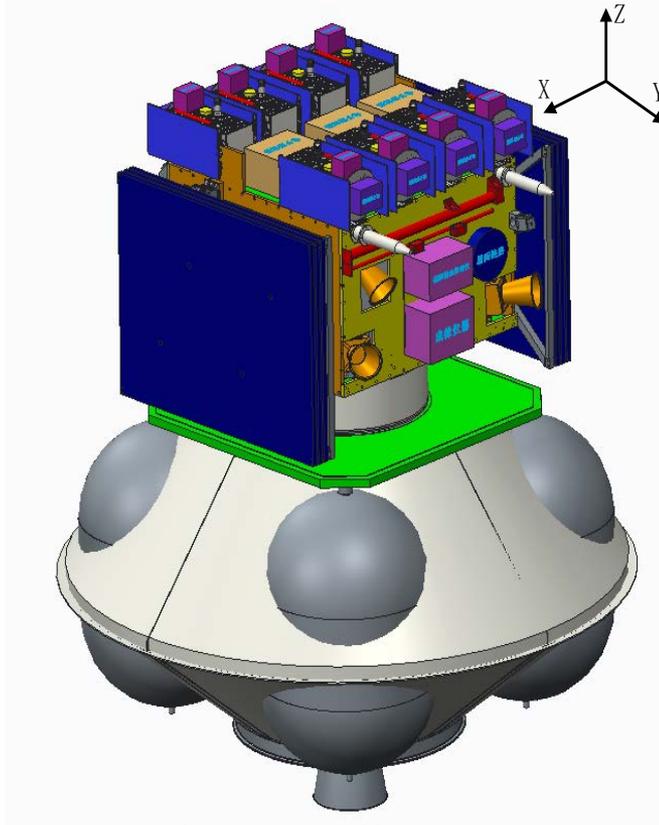
Concept study is finished.
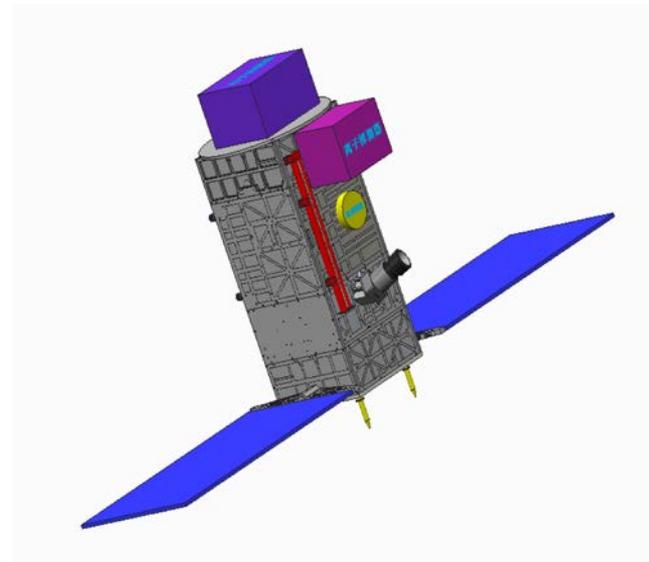
Mother satellite carries and deploy 12 CubeSats

Details and discussion on mission profile in Zhiming Cai's presentation tomorrow.

◆ Collisionless reconnection

Different fundamental spatial-scale: electron scale （~1-5km）， Ion scale （10-100km）， Meso-scale (1000km)， MHD-Macro scale（~10000km. Previous constellation spacecraft characterize the physics on the single scale corresponding to the spacecraft separation.

SAME offers simultaneous measurement at multiple important scales.

SAME constellation offers Self-Adjustable configuration in the LMN-coordinate (local boundary normal coordinate)
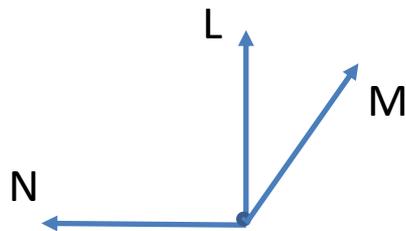
LMN-coordinate at sub-solar point at MLT=12
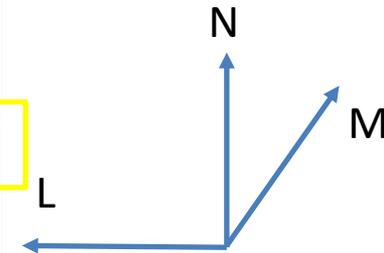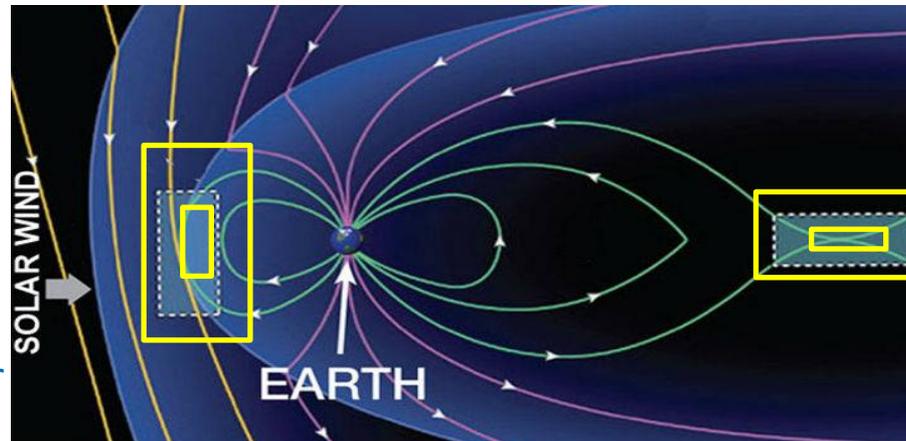
LMN-coordinate In the magneotail

1) "When magnetic reconnection occur": The cause-effect sequence of reconnection onset.

Elements of Magnetic reconnection onset
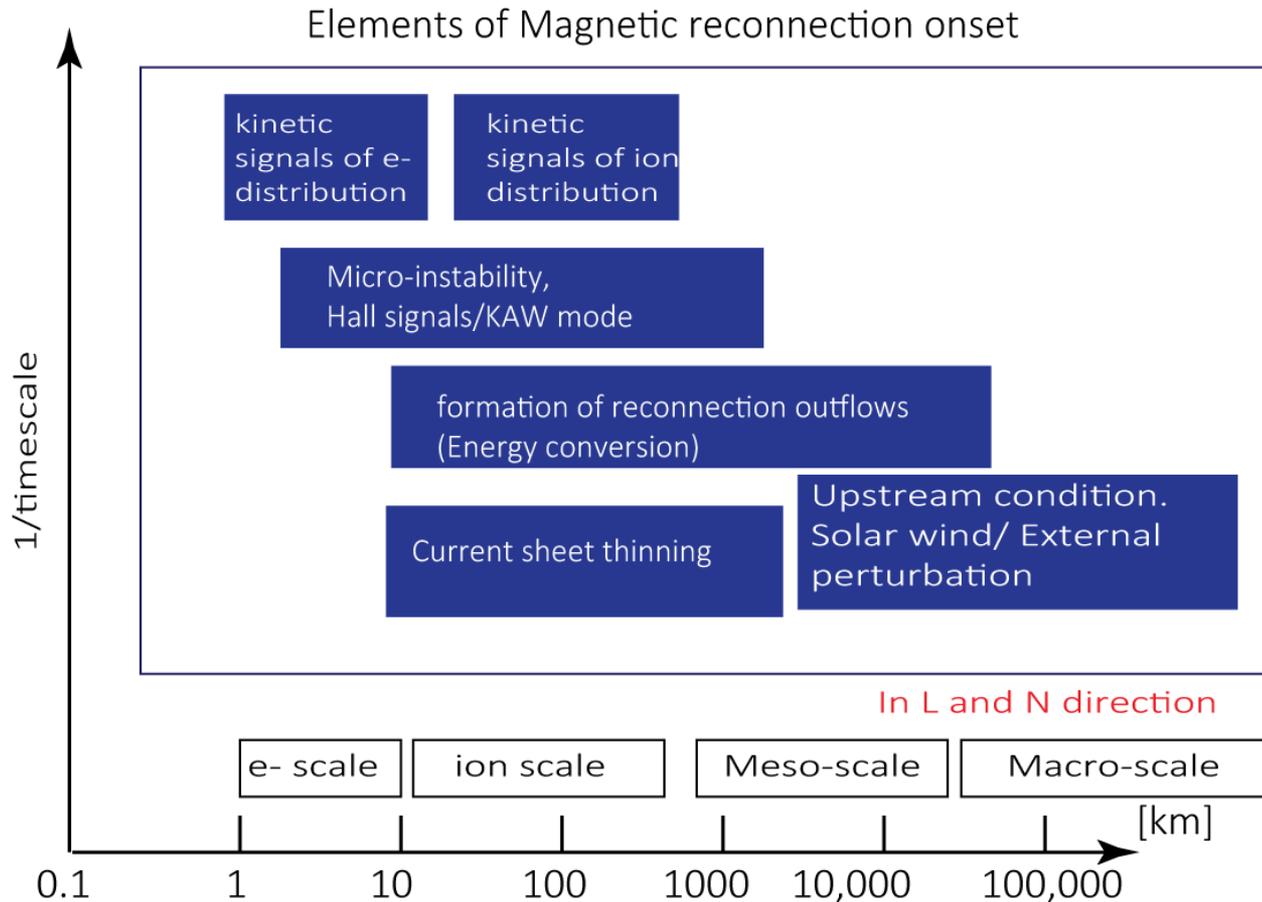
With SAME constellation displaced in the L and N, we can investigate the time-sequence of all possible elements of reconnection onset.

2) "Where magnetic reconnection occur": The spatial characteristics of reconnection X-line

The spatial characteristics of reconnection X-line
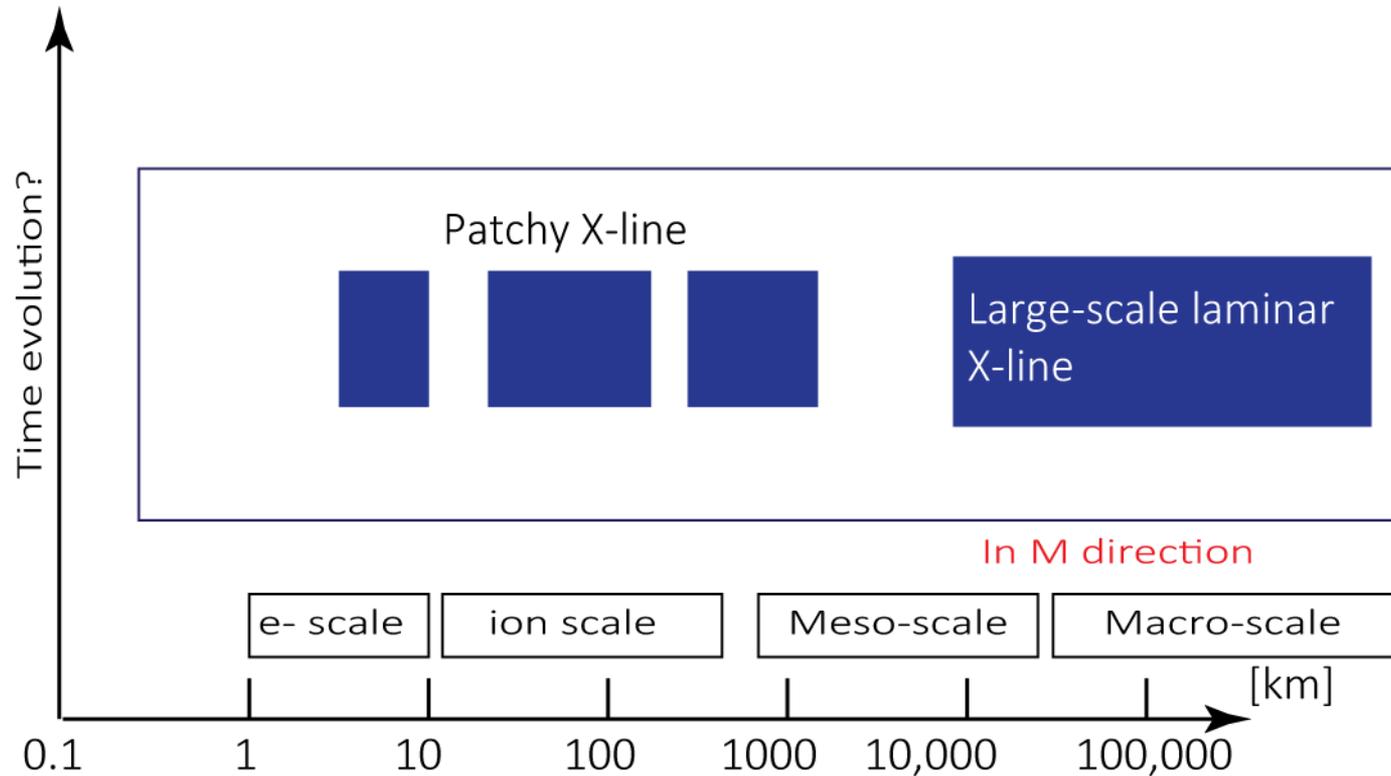
With SAME constellation displaced in the M direction, we can investigate the spatial properties of reconnection X-line in the terrestrial environment.

2) How fast magnetic reconnection occurs: Energy conversion and change of magnetic topology
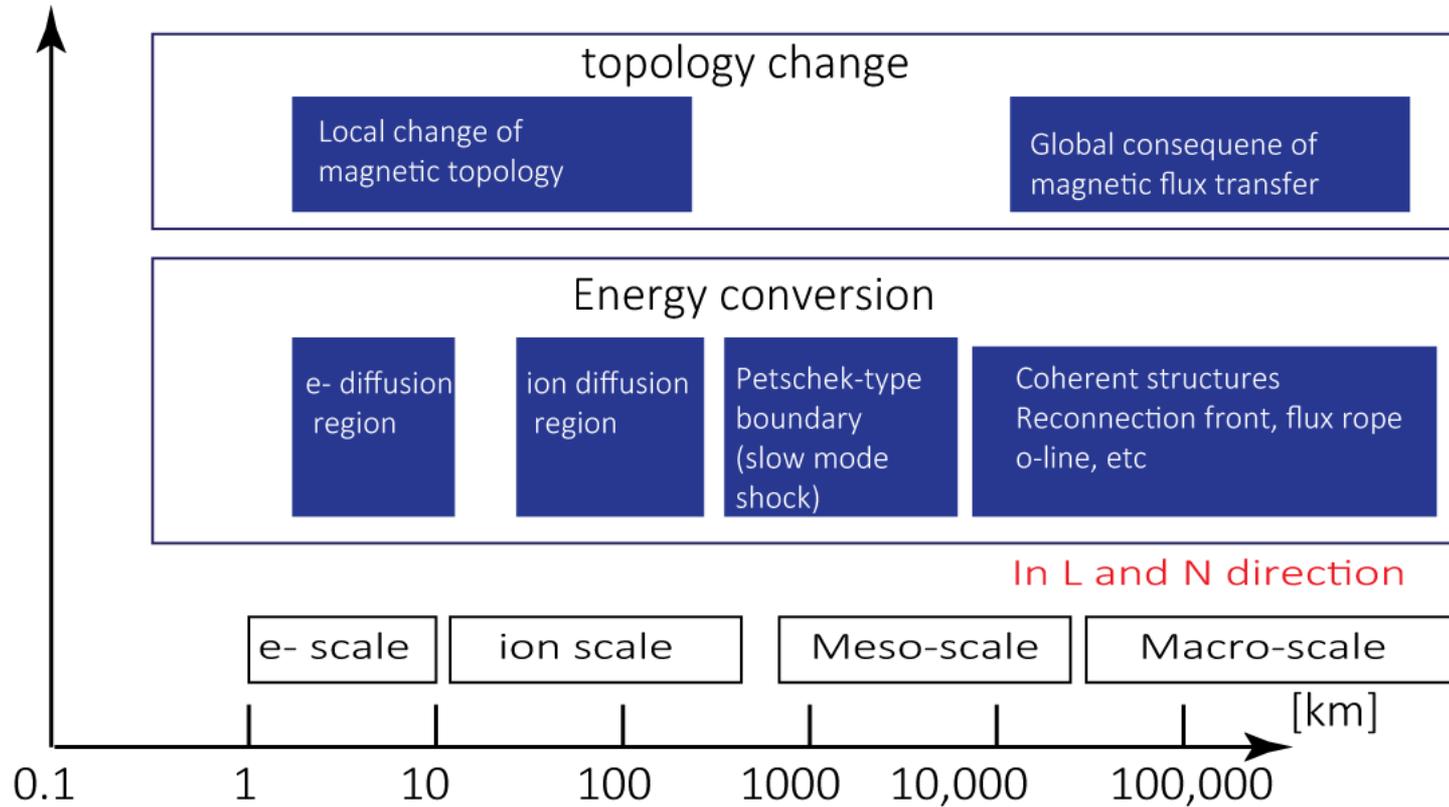
With SAME constellation, we can investigate the Meso/global-scale characteristics of energy conversion and magnetic flux transfer .
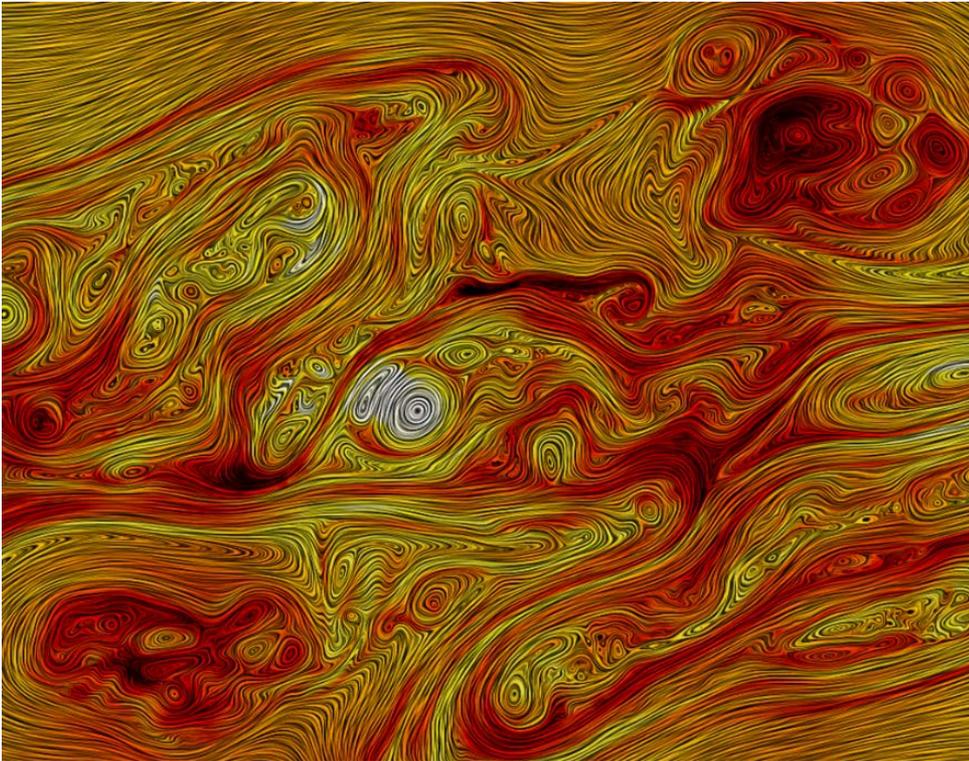
Coherent structures in formation of current sheets and magnetic islands in turbulence. (Image by Berkeley Lab)

◆ Can study Magnetosphere reconnection as well as many other important phenomena, e.g., turbulence, waves and structures.

◆ New multiple-point Analysis method: Nonlinear interpolation/extrapolation with 13-point measurements

Science opportunity with SAME

Provide understanding of when, where and how fast magnetic reconnection occurs in the solar-terrestrial interactions, ideally to the extent of predictability. The understanding of these questions is necessary for predicting the efficiency for the solar wind energy into the magnetosphere, and for energy release in the near-Earth space environment.

1) "When magnetic reconnection occur": The cause-effect sequence of reconnection onset.

the temporal sequence of current sheet thinning; External/solar wind perturbation; Upstream condition; micro-scale instability; kinetic signals of ion/electron distributions, and formation of ion outflow at multiple spatial scales. Steady reconnection versus unsteady reconnection?

Payload needed: Magnetic field (0.1nT-1000nT), thermal plasmas: electrons and ions (5eV-30keV)

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1) "When magnetic reconnection occur": The cause-effect sequence of reconnection onset.

2) "Where magnetic reconnection occur": The spatial characteristics of reconnection:

What determines the location of X-line in the magnetopause and magnetotail? The spatial characteristic of X-line: Patchy X-line versus large-scale laminar X-line?

Payload needed: Magnetic field (0.1nT-1000nT), thermal plasmas: electrons and ions (5eV-30keV)

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1) "When magnetic reconnection occur": The cause-effect sequence of reconnection onset.

2) "Where magnetic reconnection occur": The spatial characteristics of reconnection:

3) How fast magnetic reconnection occurs: Energy conversion and change of magnetic topology

Plasma acceleration and heating; Generation of waves, turbulence and structures; Reconnection front; high-energy particle acceleration.

Payload needed: Electric field (0.1mV/m-100mV/m), Magnetic field : Magnetic field (0.01nT-1000nT), thermal plasmas: electrons and ions (5eV-30keV) , energetic particle detector (30keV-1MeV)

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Thank you!