Cross-Scale

*the mission formerly known as M³*

The Cross-Scale team


Cross-Scale will study

- Multi-scale, 3D plasma dynamics
- Fundamental plasma processes responsible for energy release and particle acceleration throughout the Universe
Plasmas throughout the Universe

Several key plasma phenomena:
• Reconnection
• Shocks
• Turbulence
• Particle acceleration
• Wave-particle interactions

All of these processes are:
• Variable on several scales
• Fundamentally 3D
• Time-varying
• Poorly understood
Collisionless plasma physics: key phenomena

- **Reconnection**
  - Steady vs pulsed
  - Time scales

- **Shocks**
  - Particle injection and acceleration
  - Reformation and internal structure

- **Turbulence**
  - Heating
  - Anisotropy and particle transport

- All of these questions involve **multi-scale, 3D, time-varying** plasmas!
Related missions

Cluster
- First 3D plasma measurements
- Multiple scales, but only one scale at a time
- Limited access to electron scales, both time resolution and spatial separation
- Multi-scale extension can’t measure in 3D
- Mission end ~2010

MMS
- Access to electron scales in 3D
- Only one scale at a time
- Launch 2013
Three scales of plasmas – shocks as an example

Orientation, motion, curvature, foreshock

Ion reflection, reformation, thermalisation, downstream waves

Electron reflection, acceleration, electric fields
Cross-Scale – the three scales

Electron scale (~10km)
- Fast electron data
- 3D electric field

Ion (~500km)
- Fast ion data
- Composition

Fluid (~2000km)
- Energetic particles
- Composition
The ESA context

- Cosmic Vision 2015-2025

- Relative to other CV mission concepts, Cross-Scale is:
  - **Cheap**: <€300M, baseline of single Soyuz-Fregat launch
  - **Quick**: early in programme - by 2015?
  - **Easy**: no technological show-stoppers

- Potential for international collaboration: JAXA
  - **SCOPE**: 5-s/c mission for cross-scale plasma dynamics
  - Led by M. Fujimoto
  - More information in next talk
Summary

• Compelling science concept
  – Multi-scale plasma dynamics
• Possibility to fly within Cosmic Vision 2015-2025 programme
• Mission has many variables
  – Not fully defined at this stage
  – Compromises will have to be made
• Team is working towards a science requirements document
  – Draft available soon
• Challenge to the community
  – Need to work quickly to define mission
• We welcome all comments and suggestions