Future missions 20's and Key technologies in Space Plasma Group

**Planetary Exploration** 





**Environment Observation Near Earth** 



The giant particle accelerator : JUPITER

A further, largely unresolved problem of a fundamental nature regards the Jovian magnetosphere as a tremendously efficient particle accelerator. There is no question that lo is the primary source of particles in the Jovian environment. The new plasma populations have, however, typical energies of a few 10's eV at best. At what time and spatial scales, and by what mechanisms, does a significant part of them reach MeV energies and populate the harshest radiating environment of the solar system? The fact that such environments can exist has direct relevance to the notion of 'habitability'. A large and highly variable level of radiation may actually modify or control the emergence of life.

# **SCOPE/Cross-Scale (-2017)**

SCOPE(cross-Scale Coupling in Plasma universE) consists of five satellites, one 450kg mother satellite and four 90kg daughters, which are assumed to be launched by JAXA's H-IIA rocket at once. Five satellites fly in basically a tetrahedron formation, minimum 5km apart from each other, at their perigee of 30 Earth-radii distance. To obtain the highly accurate spatial distribution of the magnetospheric phenomena, the quality of the clock synchronization and the relative orbit determination between satellites are essential. SCOPE aims at observing the Earth's magnetotail where the ions and electrons interact with each other, with 5 satellites flying in formation. To fully resolve the time-domain behaviour and spatial distribution of the magnetospheric phenomena, a simultaneous observation by spatially distributed electro-magnetic instruments is essential.

# Three Main streams



For the purpose of studying the unresolved major problems underlying in Geospace, a small satellite mission named ERG (Energization and Radiation in Geospace) is proposed, being focused on the formation of the radiation belts associated with magnetic storms. The scientific instruments on-board are arranged to make definitive evaluation of possible mechanisms for the formation of the radiation belts. The ERG mission will achieve comprehensive plasma observations with magnetic/electric field, wave, and plasma detectors with a wide energy range (10 eV - 10 MeV) to capture acceleration, transport, and loss of charged particles in Geospace. The ERG mission also establish less expensive plasma observatory under strong radiation environment.

## We will know mechanism of space plasma phenomena perfectly!

#### Key technology

## Observation from eV to MeV without energy gap : Medium Energy P article(MEP)

New Development target:MEP-ion10 keV/q - 180 keV/qMEP-ele10 keV-100keV



Cross section of medium energy ion mass spectrometer and particle trajectories. Light blue curves are ion trajectories. Violet and white curves are start and stop electron trajectories, respectively. A black belt indicates the position of carbon foils, and a green belt represents the position of SSDs. A blue plate is MCP; it detects start and stop electrons.



Time resolution to 10 msec

We have newly developed an electron energy analyzer FESA (Fast Electron energy Spectrum Analyzer) for a future magnetospheric satellite mission SCOPE. The SCOPE mission is designed in order that observational studies from the cross-scale coupling viewpoint are enabled. One of the key observations necessary for the SCOPE mission is high-time resolution electron measurement. Eight FESAs on a spinning spacecraft are capable of measuring three dimensional electron distribution function with time resolution of 8 msec. FESA consists of two electrostatic analyzers that are composed of three nested hemispherical deflectors. Single FESA functions as four top-hat type electrostatic analyzers that can measure electrons with four different energies simultaneously. By measuring the characteristics of the test model FESA, we proved the validity of the design concept of FESA. Based on the measured characteristics, we designed FESA optimized for the SCOPE mission. This optimized analyzer has good enough performance to measure three dimensional electron distribution functions around the magnetic reconnection region in the Earth's magnetotail.

#### Spin axis antenna



Development of Spin axis antenna to be able to observe 3D electric field and plasma wave. It is key measurement to understand space plasma

## Low power & High performance

Development Magnetic Field(MGF) sensor core

- APD is a SSD-like photon detector having internal gain (Strong for noise)
- Medium energy e<sup>-</sup> was highly resolved!!!
- New MEP for electron using ESA + APD can measure electron fluxes with the energy band at least 5 keV to 50 keV



and the new electric circuit wide dynamic range (20bits)



#### Measurement technique of a few 10 keV ions

Development of Single Sided Si Detector and very low noise read-out ASIC (noise < 150e<sup>-</sup>)

