Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

PEM024-06 Room: Function Room A Time: May 26 15:00-15:15

Development of a low energy electron spectrometer for SCOPE

Yuu Tominaga[1], Yoshifumi Saito[2*], Shoichiro Yokota[2]

[1]University of Tokyo, [2]ISAS/JAXA

We are newly developing a low-energy charged particle analyzer for the future satellite mission SCOPE (cross Scale COupling in the Plasma universE).

The main purpose of the mission is to understand the cross scale coupling between macroscopic MHD scale phenomena and microscopic ion and electron-scale phenomena. In order to understand the dynamics of plasma in small scales, we need to observe the plasma with an analyzer which has high time resolution. For ion-scale phenomena, the time resolution must be as high as ion cyclotron frequency (~10 sec) in Earth's magnetosphere. However, for electron-scale phenomena, the time resolution must be as high as electron cyclotron frequency (~1 msec). The GEOTAIL satellite that observes Earth's magnetosphere has the analyzer whose time resolution is 12 sec, so the satellite can observe ion-scale phenomena. However in the SCOPE mission, we will go further to observe electron-scale phenomena. Then we need analyzers that have at least several msec time resolution. Besides, we need to make the analyzer as small as possible for the volume and weight restrictions of the satellite. The diameter of the top-hat analyzer must be smaller than 20 cm.

In this study, we are developing an electrostatic analyzer that meets such requirements using numerical simulations. The electrostatic analyzer is a spherical/toroidal top-hat electrostatic analyzer with three nested spherical/toroidal deflectors. Using these deflectors, the analyzer measures charged particles simultaneously in two different energy ranges. Therefore time resolution of the analyzer can be doubled. With the analyzer, we will measure energies from 10 eV to 22.5 keV. In order to obtain three-dimensional distribution functions of low energy particles, the analyzer must have 4-pi str field of view. Conventional electrostatic analyzers use the spacecraft spin to have 4-pi field of view. So the time resolution of the analyzer depends on the spin frequency of the spacecraft. However, we cannot secure the several msec time resolution by using the spacecraft spin. In the SCOPE mission, we set 8 pairs of two nested electrostatic analyzers on each side of the spacecraft, which enable us to secure 4-pi field of view altogether. Then the time resolution of the analyzer does not depend on the spacecraft spin. Given that the sampling time of the analyzer is 0.5 msec, the time resolution of the analyzer can be 8 msec.

In order to secure the time resolution as high as 10 msec, the geometric factor of the analyzer has to be as high as $8*10^{-3}$(cm^2str eV/eV/22.5deg). Higher geometric factor requires bigger instrument. However, we have to reduce the volume and weight of the instrument to set it on the satellite. Under these restrictions, we have realized the analyzer which has the geometric factors of $7.5*10^{-3}$(cm^2str eV/eV/22.5deg) (inner sphere) and $10.0*10^{-3}$(cm^2str eV/eV/22.5deg) (outer sphere) with diameter of 17.4 cm.