

In-situ observation of the three dimensional distribution function of space plasma

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Currently three major future space plasma missions are planned in Japan. These three missions are Mercury magnetosphere mission BepiColombo/MMO, inner magnetosphere mission ERG, and formation flying Earth magnetosphere mission SCOPE. New instruments for in-situ measurements of space plasmas required by these future missions are now under development. The goal of our development is to realize 1) plasma/particle sensors that can measure wide energy range between several eV and several MeV without any energy gaps and 2) a high time resolution low energy electron spectrometer that has time resolution below ten milliseconds to understand electron time scale phenomena. It is also required to the satellite borne instruments to be as lightweight and as low-power consumption as possible while keeping high performance.

The energy of space plasmas in the Earth's magnetosphere and planetary upper atmosphere ranges between several eV and several MeV. The origin of these plasmas is the solar wind, planetary atmosphere, and surface materials of the planets. Since the average energy of the solar wind ions is the order of keV and the energy of the plasmas in the Earth's upper atmosphere is as low as eV, the mechanism to accelerate those plasmas to MeV is one of the major problems of the magnetospheric physics. In order to understand the acceleration mechanisms of these particles, in-situ measurement of plasmas with wide energy range between several eV and several MeV without any energy gaps is indispensable. Especially the instruments that can measure medium energy range (10keV-100keV) charged particles are quite important for understanding the acceleration mechanisms. We are now developing a new ion mass spectrometer and a new electron spectrometer that have the capability to measure medium energy range charged particles.

The importance of the in-situ measurement of the low energy (1eV-30keV) electron distribution function with high time resolution in the Earth's magnetosphere has been recognized recently. The Japan-US GEOTAIL spacecraft (1992-) has provided us with high quality plasma data that enabled us to study the magnetospheric phenomena from a kinetic point of view. The GEOTAIL spacecraft has shown with data that the ion scale dynamics is indeed crucial in the close proximity of the reconnection region in the magnetosphere. In addition, the analysis of GEOTAIL plasma data and the numerical simulations have made us recognize the importance of the electron scale phenomena in the reconnection region. The microscopic distribution of the electrons is still unknown because of the insufficient time resolution of the electron measurements. A new low energy electron spectrometer that has a time resolution as high as 10msec (to obtain 3-D electron distribution function) is under development.