Development of the medium-energy ion mass spectrometer for future missions in the inner magnetosphere

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It is well known that intense fluxes of energetic ions (ring current and radiation belt particles with energies of several hundred keV up to a few MeV) are injected into the inner magnetosphere of the Earth during magnetic storms and substorms. However, their acceleration mechanisms and sources have not been well understood due to insufficient data of medium-energy ions (from several 10 to ~200keV/q). This is one of the most important problems in magnetospheric physics, and in general, space physics. The key information for this study is the energy distribution, charge state (q) and mass (m) of particles. We recognize that detailed information is important on ion species and three-dimensional distribution functions in this energy range, also from a viewpoint of the influence of plasma waves on the evolution of the storm time ring current.

We have started to develop a Medium energy Ion Mass Spectrometer (MIMS), which can measure energy (E), mass (m), and charge state (q) of each ion in the medium-energy range. The instrument consists of 1) an energy-per-charge (E/q) electrostatic analyser, 2) a Time-Of-Flight (TOF) section that provides velocity (v) of particles, and 3) Solid-State Detectors (SSD), which measure the total energy (E). The triple coincidence (the start and stop signals of the TOF data, and the SSD signal) is also useful for discrimination of true particle signals from background noise. Thus the instrument can provide the particle information of E/q, v and E, from which the charge state (q) and mass (m) can be calculated unambiguously. Most of the techniques are conventional in principle, but the actual technologies are non-trivial. Therefore, we need new ideas to develop the instrument that provides us unprecedented data of ion distribution functions in medium-energy range, with lightweight and small size. Our novel design of the electrostatic analyzer makes it possible to obtain full pitch angle coverage and high sensitivity in a rather small size. Furthermore, our sophisticated design of the TOF sector makes the weight much lower, so that our instruments will be able to be accommodated on a microsatellite.

We will make a presentation on the progress in the analyzer development and our future plan.