Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PCG31-17 Room:202 Time:May 28 16:15-16:30

The design of the suprathermal ion mass spectrometer (STIMS)

ISHIGURO, Keisuke[1*] ; HIRAHARA, Masafumi[1]

[1]STEL, Nagoya Univ.

Ion escape processes are critical issues to solve atmospheric evolution of non-magnetized planets, e.g., Venus and Mars. Many studies about the ion escape have been conducted by both observational and theoretical methods. There is, however, a problem that qualities of in-situ observations have not been sufficient to identify the detailed suprathermal plasma dynamics, especially about molecular ions, around the non-magnetized planetary ionospheres. A suprathermal ion mass spectrometer (STIMS) has been designed for future in-situ observations of three dimensional velocity distributions for suprathermal ions around the planetary atmospheres.

The STIMS consists of (a.) an energy analyzer and (b.) a mass analyzer. A field of view of the STIMS is about 4 pi sr per a half spin of spin-stabilized spacecraft. A target energy range is from 0.1 to 300 eV, which corresponds to suprathermal energies, and a mass range is from 1 to 50 amu. An energy resolution, △E/E, is less than 5%, and a mass resolution, M/△M, is over 10.

(a.) An energy analysis of the STIMS is carried out in a top-hat type electrostatic analyzer, which deflects incident ions by 90 degrees and leads them to an entrance of the mass analyzer. Only ions that fly along a center radius of spherical electrodes are able to get to the mass analyzer.

(b.) The mass analyzer of the STIMS is mainly made up of a pre-acceleration section and a magnet section. The magnet section, which has a cylindrically symmetric structure, is divided into sixteen regions by permanent sector magnets. Firstly, in the pre-acceleration section, ions which got through the energy analyzer are accelerated or decelerated by an acceleration voltage E eV, whose magnitudes depend on mass number of the ions M amu. Secondly, the accelerated/decelerated ions experience Lorentz force in the magnet section, and reach a micro-channel plate (MCP), with semicircular trajectories. By sweeping magnitudes of the acceleration voltage E, only ions that conserve square root of product of their masses and kinetic energies, i.e., $\sqrt{ME}$, are able to reach the MCP.

As for observations of molecular ions, magnet type mass spectrometers have a great advantage that it is possible to detect the molecular ions without dissociations. However, this type of spectrometer has several disadvantages; (1) it is difficult to discriminate between noise signals and ion signals at the MCP because this type of spectrometer does not take signal coincidences; (2) this type of mass spectrometer tends to be heavier than other types of spectrometers due to installing magnets; (3) magnetic field of the magnets might cause undesirable effect on other observation instruments on spacecraft.

In this presentation, we will introduce design concepts and specifications of the STIMS.

Keywords: ion mass spectrometer, suprathermal ion, non-magnetized planet, planetary ionosphere