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Development of a space-borne ion mass spectrometer for measurements of ionospheric ions

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Recent satellite observations show that atomic hydrogen, helium, and oxygen ions escaping from the polar ionosphere are transported to the magnetotail along the geomagnetic field line. However, their escape mechanisms were found to be highly complicated. To know how the respective ion species of thermal energy in the lower ionosphere obtain nonthermal energies is especially important for the understanding of the ion escape mechanisms. Therefore, it is significant to observe suprathermal ions of the respective species using a mass spectrometry technique.
The Neutral Mass Spectrometer (NMS) which we developed and installed on the Canadian CASSIOPE satellite will be launched in the winter of 2010. The objective of the NMS instrument is to observe nonthermal neutral particles that are closely linked to the ion escape mechanisms. We applied the technique used in NMS instrument to a new ion mass spectrometer by improving this instrument. The purpose of this study is to develop a space-borne ion mass spectrometer for observations of the suprathermal ions related to the ion escape from the polar ionosphere. In addition, we newly developed a low energy ion beam generator because ions of suprathermal energy are required for the laboratory calibration of the ion mass spectrometer.
The advantage of this ion mass spectrometer is that the high time resolution is achieved because this instrument can simultaneously perform the mass spectrometry using the time-of-flight technique and the velocity measurement using the two-dimensional position detection technique. This advantage will provide the spatial resolution of the ion escape observation that is about ten times higher than those by the conventional suprathermal ion spectrometers. It is very difficult for the conventional ion beam generators used in the laboratory experiments to produce ion beams with energies lower than a few eV. The ion beam generator we developed first produces supersonic neutral beam using a nozzle and then convert it into the ion beam by ionization using an electron gun.
In this presentation, we report on development status of the ion mass spectrometer and the low energy ion beam generator.