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Construction of a calibration system for developing space-borne particle analyzers

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To study physical phenomena in the terrestrial/planetary ionosphere and magnetosphere, it is essential to consider effects of ionized particles and neutral particles which influence each other. For detailed investigations, in-situ observations by spacecraft are required. So we have been developing space-borne particle analyzers for planetary atmospheres with new technologies. As developing these analyzers, it is necessary to construct an appropriate calibration system for them.

For the calibration, we set the analyzer in a vacuum chamber, and irradiate an ion beam towards it, and investigate its response. We have already been constructing a calibration system (ion beam line) which can irradiate an ion beam of which energy per charge range is from 10keV/charge to 150keV/charge. It is necessary, however, for the system to irradiate a suprathermal ion beam of several tens eV/charge. Particularly the system provides the other species of atomic ion beams: H^+, He^+, O^+, N^+, Ar^+, over the energy per charge range from 10eV/charge to 10keV/charge in addition to the other species of molecular ions like $N_2{}^+$, $O_2{}^+$, $CO_2{}^+$. We have been constructed a new beam line which can irradiate an ion beam of which energy per charge range is from 10eV/charge to 10keV/charge. Eventually, we will construct a calibration system which can control each beam line integratedly. In this paper, we report the development of the suprathermal ion beam line.

The suprathermal ion beam line is mainly composed of six parts: (a) ion source, (b) electromagnetic ion mass spectrometer, (c) beam expander, (d) main acceleration, (e) vacuum chamber, (f) multi-axial turntable. In the ion source, introduced gases form a gas cylinder are ionized by thermal electrons emitted from filaments. The ionized particles are initially accelerated and discriminated by the electromagnetic ion mass spectrometer. The discriminated ion beam is expanded by electrostatic 2D raster scanning, and is parallelized through the deceleration and acceleration in the beam expander. The ion beam is accelerated or decelerated for the specific energy in the main acceleration. The analyzer is set on the turntable in the chamber. Incident angles of the beam are controlled by changing the elevation and azimuth of the turntable system. We can control the beam property to change parameters: (1) thermal electrons flux and its acceleration voltage, (2) pre-acceleration voltage for ionized particles, (3) strength of the magnetic field of the electromagnet, (4) raster scanning and parallelized electric field for enlarging the beam cross-section uniformly, (5) main acceleration/deceleration voltage, (6) elevation and azimuth of the turntable system. We have also been developing a system which can control them centrally and remotely by using a computer. As interfaces, we use wireless LAN, RS-232, and USB and make programs with LabVIEW. We have added a monitoring and alert system for multipoint vacuum components.

So far, we have constructed the system expect for the turntable system and can irradiate a specific energy beam which is expanded and parallelized sufficiently. We set up a MCP measurement system to measure the beam intensity and cross-section profile. We will present the updated status of calibration system and the beam properties in this paper.

Keywords: calibration system, ion beam line, suprathermal ion beam, particles analyzer, magnetic ion mass spectrometer, remote control