惑星高層大気の直接観測に向けた中性粒子質量分析器ANAの較正試験

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Experimental development of Atmospheric Neutral Analyzer (ANA) for in-situ observations of planetary upper atmospheres

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The dynamics in the neutral upper atmosphere of the Earth and the other planets affect the environment of their ionospheres and the thermospheres. Observations in the terrestrial and planetary neutral atmospheres such as the Earth, Mars, and Venus have been mostly carried out by remote sensing, while in-situ observations of neutral atmospheres have been accomplished only few times. The in-situ observations utilizing by spacecraft are needed for understanding atmospheric circulations, heating, and dissipation.

We are newly developing a Bennett-type radio-frequency mass spectrometer, which is called Atmospheric Neutral Analyzer (ANA). The ANA is capable of observing 2-D velocity distributions, from which density, wind velocity and temperature are derived, for each component of neutral species. The ANA consists mainly of five sections: an entrance slit, an ionization section utilizing electron gun, a pre-acceleration section, a Radio Frequency (RF) stage for mass spectrometry, and a detection section which obtains 2-D velocity distributions in combination of MCP with 2-D position-sensitive device. We now concentrate on the development of the whole ion mass spectrometer after the ionization section.

We use a suprathermal ion beam line for the calibration of the ANA. For the calibration, we set the engineering model of the ANA in a vacuum chamber, and emit several types of ion beams, and investigate its responses. Because our beam line facilities are currently under development, it is still difficult to emit suprathermal ion beams stably. In the previous performance verification, we could not obtain adequate beam properties with Ar^+ beams. In order to improve the beam profiles, therefore, we attempt to investigate the responses of the ANA by utilizing heavier ions such as Xe^+ (130amu).

As mentioned above, suprathermal ion beam flux varies according to a particle species. The ion beam which it is easy to irradiate most is Ar^+. In addition, the targeted mass resolution of ANA, i.e. m/(delta m) is equal to 10. Therefore, we are now preparing the calibration to verify whether the mass separation between the Ar^+ (40amu) and $CO_2{}^+$ (44amu) will be possible or not.

In the presentation, we will show the overall design of the ANA regarding the mass spectrometry and the characteristics investigated by the simulation and the beamline experiments.