惑星大気の直接観測に向けた中性粒子質量分析器 ANA の設計

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Design of Atmospheric Neutral Analyzer (ANA) for In-situ Observations in Terrestrial and Planetary Neutral Atmospheres

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Observations in terrestrial and planetary neutral atmosphere such as the Earth, Mars, and Venus have been mostly carried out by remote sensing, while in-situ observations of neutral atmosphere have been accomplished only few times. In non-magnetized planets, neutral particles directly interact with the solar wind that induces atmospheric escape. Moment and energy of the neutral particles are transported from the lower atmosphere into the thermosphere, and their dynamics fluctuates neutral density and wind in the thermosphere. The effects of dust storms in the lower atmosphere on the thermospheric temperature and composition are also reported. In order to understand the response to solar activity and the interaction with the lower atmosphere, it is necessary to measure motion of neutral particles which is represented as density, temperature, and wind.

Atmospheric Neutral Analyzer (ANA) which we are developing can measure neutral density, composition, temperature, and wind. The ANA can simultaneously measure each physical quantity by obtaining 2D velocity distributions of each neutral particle species. The ANA consists of five sections; the entrance aperture with the planar entrance slit, the ionization section utilizing electron beam, the pre-acceleration section, the Radio Frequency (RF) mass spectrometer utilizing RF electric field, and the detection section which obtains 2D velocity distributions in combination with CCD and MCP.

In addition to the previously designed RF spectrometer, we newly designed the entrance aperture and the pre-acceleration section. We considered various cases of different structures and voltage of electrode in the pre-acceleration section. The effects of electric filed deformation and spreads of particle trajectories in the each case were examined in numerical simulation of electric field and particle trajectories using SIMION. We fixed the electrode geometry and voltage which have little effects of electric deformation in the pre-acceleration section. After that we optimized the design of ANA in combination with the RF spectrometer and the newly designed sections. In the future we will fabricate a prototype of ANA and then calibrate of the analyzer in a laboratory with the low energy ion beam facility which is under development.

In the presentation, we will show the overall design of ANA and specifications such as mass resolution, measurable range, and accuracy which were estimated by results of the numerical simulation.