Development of neutral mass and velocity analyzer on board the spacecraft

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The number density of neutral particles at the exobase is 10^8-10^11[cm^(-3),and that of ionizing particle is 10^6[cm^(-3)]. Therefore, neutral particles are the majority of exospheric particles. But, from the difficulty of measuring the neutral particle velocity, the measurement of the velocity distribution function of neutral atmosphere has never been done before.

Neutral particles in the exosphere have at least two different origins. One is the particles produced through the non-thermal processes and the other through thermal processes. The non-thermal component of neutral atoms originates from the dissociative recombination of molecular ions, and is one of the most interesting targets of observation. It is well-known that this process may produce energetic atoms. On the other hand, the thermal particles are those that have obtained upward velocities in the last collision at the exobase. In the exosphere, the inter-particle collision frequency is so small that the velocity distribution function retains information about the density, kinetic temperature, and mean motion of individual neutral species at the exobase.

It was shown in past observations that a large amount of oxygen ions escape from the polar ionsphere. The plasma escape is an important clue related to the origin and the structure of the magnetosphere.

It is important to develop a new type of mass and velocity analyzer that can measure the velocity distribution function directly in the exosphere. This kind of analyzer will become a powerful tool to clarify the dynamics of the tenuous exospheric gas and the escape mechanism of the atmosphere of the earth.

In the development of our new detector, we have used the technique of ion acceleration perpendicular to the incoming velocity, which has been used for the TOF-type neutral mass velocity spectrometer. However, position detectors (MCP) are used instead of the TOF technique to measure the velocity of neutral particles.

We here report the principle and design parameters of the new instrument and the result of the numerical calculation on the position detection accuracy.