# Development of a Compact Ion and Electron Energy Spectrometer for Space Plasma Measurement

*Kazuma Masaki[1], Yoshifumi Saito[2]

1. The University of Tokyo, 2. Japan Aerospace Exploration Agency

We are developing a compact ion and electron energy spectrometer for space plasma measurement. In this study, we have evaluated the performance of a proto-model analyzer. The energy spectrometer is a concentrically stacked 90-degree cylindrical electrostatic analyzers, which can make "in-situ" observation of low energy charged particles ranging from a few eV to several tens of keV. The analyzers are made of PEEK resin plastic which is metalized partially and have a radius of about 2cm, making it small and lightweight. By assembling multiple analyzers, we can detect charged particles from various directions. Ions and electrons are simultaneously energy analyzed by the stacked cylindrical electrostatic analyzers. The energy analyzed electrons and ions from different analyzer are separately detected. The task at hand is to evaluate the performance of the proto-model analyzer and to design the analyzer so that it can function properly in space with as little sensitivity as possible depending on the direction.
So far, we have evaluated the performance of the prototype analyzer through experiments and simulations. In the experiments, we have placed the analyzer on a gimbal in a vacuum chamber, and the gimbal was rotated in various directions while being irradiated with nitrogen ion beam of about 2keV energy to investigate the angular dependence of the analyzer. UV irradiation was also performed to investigate the response against UV light. In the simulation, we investigated the angular dependence of the analyzer and compared the results with the actual experiment data.
From the results of experiments and simulations, we have found that the detection sensitivity of the proto-model analyzer is biased in the horizontal angle direction. In addition, we have found that two of five stacked cylindrical analyzers are not functioning as the energy spectrometer and needed to be improved. It may be possible to separate the ion and electron signals without detecting the position of the energy analyzed particles. Through UV irradiation experiment, we have found that it is necessary to reduce the UV light contamination.
Based on the results of our proto-model test, we have designed a new analyzer that improves on the proto-model analyzer. The shape of the cylindrical analyzer has been changed from that of the proto-model analyzer so that the two of five stacked cylindrical analyzers that are not functioning can be used. In addition, the width of the cylindrical analyzers are widened in order to improve the non-uniform sensitivity in the horizontal direction. However, the improved analyzer is still in the simulation stage and has not yet been manufactured and tested, so further development is necessary. In addition, we are still looking for ways to reduce the UV contamination, and further experiments will be necessary. This is a future issue along with the establishment of a method to separate ion and electron signals without position detection. We are also designing a new analyzer. We would like to manufacture and test it in the future.

Keywords: plasma, electrostatic analyzer, energy spectrometer