Design of Small Ion Mass Spectorometer for Comet Interceptor Mission

*Rurie Mizuno[1], Satoshi Kasahara[1]

1. The university of Tokyo

Time-of-flight mass spectrometers have measured dynamics and compositions of space plasmas. In particular, linear-electric-field time-of-flight analyzers have high mass resolution and are useful for in-situ measurement. Comet interceptor mission which is planned by ESA and JAXA will also use this type of mass spectrometer.

Comet interceptorInterceptor, currently studied in ESA and JAXA, is a mission to observe a dynamically new comet by flyby multi-spacecraft flyby. The mission goal is to characterize a dynamically new comet, which is relatively pristine compared to returning comets explored so far, to obtain a unique view along the evolutionary path of comets from their formation to migration into the inner solar system. One of the key measurements to achieve this goal is the ion measurement, which provides information on nucleus/coma composition as well as the solar wind-coma plasma interaction. Major molecules in a cometary coma, such as H_2O, CO_2, CO, NH_3, and hydrocarbons, consist of volatiles H, C, N, and O. Therefore, in this mission we have to divide the component of coma: C^+, N^+, O^+. To distinguish these atomic ions, the ion mass spectrometer needs relatively high to meet the constraint of the mass resolution, $m/\Delta m > 50$. There is also a constraint of on the size: volume (< 4U), to be accommodated on a relatively small (~24U) Japanese sub-spacecraft for this mission.

However, there has been no ion mass spectrometers meeting satisfying this resolution and size constraint simultaneously. Here we designed a small and high mass resolution ion mass spectrometer for the Comet Interceptor mission. For the high mass resolution, we adopt a linear-electric-field time-of-flight technique. To reduce the size of linear-electric-field time-of-flight the analyzer, we optimized the sensor optics by using a software keeping their high mass resolution. We simulated the design with through SIMION 3D calculation.
Changing the electrode’ s forms and voltages, we obtained a high mass resolution $m/\Delta m$>50~130 at full width at half maximum, with under the following condition: the sensor radius was 50 mm and height was 70mm.

Keywords: Comet Interceptor Mission, Mass Spectrometer

