Development of a Neutral Particle TOF-MS for Future Solar System Explorations

*Daichi Fukuyama[1], Yoshifumi Saito[2], Kazushi Asamura[2], Shoichiro Yokota[3]

1. The university of Tokyo, 2. ISAS/JAXA, 3. Osaka University

In-situ observation is important in solar system exploration because of the difficulty in returning samples from a gravitational celestial body. Especially, in-situ mass spectrometry of celestial surface material is indispensable to understand the evolution of the moon and planets since mass spectra bring us various information such as the isotope composition. For the purpose of in-situ material analysis, mass spectrometers are used for recent planetary explorations. In addition, observations by lunar explorer in recent years reports the result of remote sensing suggesting the existence of H_2O in the moon polar permanent shadow, but the existence is ambiguous since the observations have problems such as difficulty in discriminating between H_2O and OH. The need for a mass spectrometer to demonstrate the presence of water by in situ observation is increasing.

Mass spectrometers on planetary explorers must be compact and lightweight, but mass spectrometers that have both the compactness and high mass resolution have not been developed yet. Therefore, we are developing a compact and moderately high mass resolution TOF-MS (Time-Of-Flight Mass Spectrometer) for measuring neutral particles on the moon and planets.

TOF-MS accelerates ions with an electric field. The accelerated ions fly at a fixed distance and the mass information is obtained from their flight time. In general, the flight path of ions must be long for realizing high mass resolution. In order to increase flight distance without enlarging equipment, a reflectron type TOF- MS, which reflects ions by electric field is adopted. Since the ion trajectory is dispersed as the ion flight distance increases, the detection efficiency decreases when the number of reflection increases. Therefore, our new reflectron type TOF-MS is equipped with a triple reflection mode with high mass resolution and a single reflection mode with high sensitivity. These measurement modes can be switched electrically depending on the observation targets. Simulation results show that the mass resolution is 360 in the triple reflection mode and 180 in the single reflection mode. Currently, we are manufacturing a test model whose size and potential are optimized.
In this presentation we will report the design of our new reflectron type TOF-MS that is optimized by analytical calculation and numerical simulation.

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