Dust Anwalyzer with time-of-flight mass spectrometry on board spacecraft --- prelimenary experiments ---

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To clarify the origin of the dust particles, it is important to observe the chemical compositions in-situ as well as dust fluxes, velocities, directions and masses. For that purpose, we are developing an new type impact-ionization dust analyzer with TOF (Time-of-Flight) mass spectrometry. In preliminary experiments with a prototype, we measured the total flight time of ions produced by pulsed laser irradiation. Then, we made high velocity dust particle impace experiment. In these experiment, Ag particles around 1micrometer diameter are used as impacting particles, and they are accelerated up to several kilometers per second by Van de Graaff electrostatic accelerator.

All the dust analyzers so far are only capable of measuring the velocity and mass of the dust particle by using the plasma produced by high-velocity impact of the dust particle. To clarify the origin of the dust particles, it is important to observe the chemical compositions in-situ as well as dust fluxes, velocities, directions and masses. For that purpose, we are developing an impact-ionization dust analyzer with TOF (Time-of-Flight) mass spectrometry, which has to be small-sized and lightweight. TOF mass spectrometry is performed by measuring the total flight time of the ions from being extracted from the ion source to the detector through the field-free drift region. We designed a prototype device based on reflectron mass spectrometer, proposed by Mamyrin (1973), and we performed preliminary experiments with pulsed IR laser irradiation and high velocity particles impact as the ion source.

In the case of formation of ions by IR laser irradiation, ions have initial energy, with significant energy distribution. This initial energy distribution decreases mass resolution. So the ion source is improved to produce ions with initial energy of less than 40 eV which is initial energy of ions produced by interplanetary dust impact. First, laser irradiation experiments with linear TOFMS were performed to confirm ion generation from the target.

Then, we made high velocity dust particle impact experiment. In these experiment, Ag particles around 1 micrometer diameter are used as impacting particles, and they are accelerated up to several kilometers per second by Van de Graaff electrostatic accelerator at HIT (High fluence Irradiation facility, University of Tokyo). The impact experiments were performed with linear TOFMS. The spectra of linear TOFMS are divided into two types. One is the case that one particle impacts on the target with charges. The other, on the other hand, several particles impact at the same time or fragments produced by colliding of an Ag particle with the front mesh impact on the target. Since the initial energies of ions of both target material and impacting particles is less than that under laser irradiation, mass resolution become higher.

We will analyze the spectra of the reflectron with high-velocity particle impact, and compare the results with pulsed IR laser irradiation. Finally, we perform experiments with a new type of reflectron which can focus ions not only in time but also in space.