1. Title

2. Research Term
FY2005〜2006

3. Research Fields
Space Utilization Technology

4. Research Categories
Exploration Research for Space Utilization

5. Research Theme
Development of light-weight large-area dust/debris telescope for space

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8. Summary of Research

In-situ measurements of dust and space debris particles around the Earth is one of the most important measurements of space environment. In this study, we will develop a light-weight impact-ionization dust/debris detector with a large sensor area. We expect to develop a dust measurement system whose sensor area is 0.1m² as light as 2kg including electronics. Using the total charge and rise time of impact-generated plasma, we can obtain information of mass and velocity of impacted particles.

Impact ionization has been found to be the most sensitive and versatile method to detect and analyze small dust particles in space. Generated ions and electrons are separated by an electric field in front of the target, collected onto electrodes and converted into electronic signals by charge sensitive amplifiers. The amplitude and risetime of these signals are functions of the mass and velocity of the impacting particle and the time-of-flight mass spectrum of the ions relates to the chemical composition of the impacting grain. The most suitable shape of this detector is still in controversy. MDC on board NOZOMI has a rectangular box. Although this is lightweight, the box detector has a symmetry problem: depending on the location of the projectile impact, signals get inconsistent.

Here, for the purpose of developing light-weight and large-area dust detecting system, a new cylindrical-shape dust detector is proposed. This detector is composed of a target plate and a grid, which are set in parallel. Since this structure is completely symmetrical, the detector area can be extended easily. Mass and volume, \( V \), of the detector will be proportional to the target area, \( S \).
Previously we developed a detector whose target diameter is 15cm. We planned to enlarge the target as large as 30cm. By March 2006, we performed hypervelocity dust impact experiments on the developing dust detector using Van de Graaff dust accelerators at HIT, University of Tokyo and Max Planck Institute for Nuclear Physics in Heidelberg, Germany. Silver, carbon, and iron micron-sized dust particles were accelerated as projectiles. We confirmed that the detector produces the relation between signal characteristics and dust mass/velocity. The obtained signal characteristics of dust impacts were not changed according to the position of dust impacts.

In 2006, we made an improved wide-area detector whose target diameter is 30cm. We performed hypervelocity dust impact experiments on the developing dust detector using Van de Graaff dust accelerators. Every signal is carefully analyzed, and calibration curve is plotted for each condition. The new wide-area detector also has capability to obtain mass and velocity of an impacting dust particle from impact-generated plasma charge. This can be extended velocity range higher than 10km/s. The obtained signal characteristics of dust impacts were not changed according to the position of dust impacts. Our result shows the great feasibility of a light-weight and large-area dust detector in space.

9. Publications

At present, a full paper is under preparation.

We will have two international presentations in 2007.