Observation of secondary ions emitted from Phobos by the mass spectrum analyzer on Martian Moons eXploration (MMX)

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Space-borne ion mass spectrometers have been used many plasma missions and have succeeded in the measurements of distribution function of mass-identified ions. Such ion mass spectrometers can be used for remotely measuring the planetary surface materials because airless bodies emit secondary ions due to the solar wind ion impact. The ion mass analyzer on Kaguya actually detected secondary ions from the Moon and provided ion emission maps for several species. For achieving such remote but direct ion measurements from airless bodies' surface, we are developing a high-mass-resolution analyzer for Martian Moons eXploration (MMX).

A number of in-situ low-energy ion measurements in terrestrial or planetary plasma environments have been done with a variety of ion analyzers onboard spacecraft. For three-dimensional energy analysis of low-energy charged particles, the top-hat electrostatic method using spherical deflectors or toroidal deflectors1 has usually been applied because of its large geometric factor and uniform angular response while requiring relatively few resources. The mass analyses of the space plasmas have been actually conducted near the Earth, Mars, Venus, other planets, the Moon, and asteroids. For almost all the cases, the TOF techniques using thin carbon foil were employed in combination with the top-hat electrostatic energy analyzers. Moreover, a TOF technique with a specific electric field, called a linear electric field (LEF), was recently developed and was used for measuring space plasmas around the Moon and planets.

We developed an LEF-TOF ion mass analyzer, MAP-PACE-IMA, for Kaguya, with a mass resolution of M/dM~20, which has measured ions originating from the lunar exosphere and surface. In addition, we are now preparing MPPE-MSA with M/dM~40 for the BepiColombo mission, which will observe the plasma environment around the Mercury. For the MMX mission, we have started developing a mass analyzer of M/dM~100 for future composition measurements of ions emitted from the surface Phobos and the Mars atmosphere. We will present instrumentation and current status of the ion mass spectrometer of M/dM~100 for MMX.
In addition, we analyzed the measurement results of ion fluxes from the Moon by the ion mass analyzer on Kaguya in order to estimate such ion measurements. Although the mass resolution is not high, we have made distribution maps for several ion species. We will also the observation results of the lunar ions and will discuss the future observation.

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