

Development of an ion energy mass spectrometer for application on board three-axis stabilized spacecraft

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We have developed an ion energy mass spectrometer for use aboard three-axis stabilized spacecraft. This spectrometer measures the three-dimensional distribution function of mass-discriminated ions with a high sampling rate using electrostatic energy analysis and time-of-flight mass analysis. Three-axis stabilized spacecraft make it difficult to obtain complete coverage of all possible plasma arrival directions. We have added angular scanning deflectors to a cylindrically symmetric analyzer to provide a hemispherical (2π str) field-of-view. Ion analyzers need suitable sensitivity with respect to surrounding space plasma fluxes, whose intensities vary greatly depending especially on plasma regions such as the solar wind and the planetary magnetospheres. To obtain a wide range of sensitivity, we equipped the analyzer with sensitivity control electrodes. Ions originating from planetary atmosphere and surface include various ion species such as Na^+ , Mg^+ , Al^+ , and Fe^+ . The time-of-flight device of our spectrometer applies a peculiar electric field, called a linear electric field, which increases linearly with the penetration length of incident ions to enable mass resolution higher than that of conventional time-of-flight techniques. In this electric field, ions bounce in simple harmonic motion, where the energy and flight path no longer affect the flight time and thus the mass resolution. We have designed and fabricated the ion energy mass spectrometer, and have evaluated its performance through laboratory experiments. As one application of the ion energy mass spectrometer, in situ measurement of the lunar alkali atmosphere by a lunar orbiter named 'SELENE' is planned.