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Development of Medium Energy Ion Mass Spectrometer for the Exploration of the Earth's Magnetosphere

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In the earth's magnetosphere, particle acceleration mechanisms and transport processes have been the subjects of intensive research. For instance, the earth's ring current ions are characterised by energies of ∼10-∼200 [keV]. On the other hand, typical energies of ions in the ionosphere and solar wind are considerably lower (less than 1 [eV] and ∼1[keV/nuc], respectively), though they are considered to be the source particles. Thus, observations for the clarification of the build-up processes are strongly required. Despite their importance, however, measurement methods of medium energy (∼10-∼200 [keV]) ions are not well established due to technical difficulties. It is extremely important to measure energy (E), mass (m), and charge state (q) of each ion for the investigations of the transport processes and energisation mechanisms of ions; m and q of each ion provide information on their origins (the solar wind and the terrestrial ionosphere). Furthermore, measurements of their three-dimensional distribution functions are also required. In order to obtain the above data, we develop medium energy ion mass spectrometer that is comprised of electrostatic analyser (ESA), time-of-flight (TOF) unit, and solid-state detectors (SSDs). We newly invented "cusp type" ESA, which covers from ∼10-∼200 [keV/q]; the novel design enables a reduction in the size. It has high sensitivity of 2x10-2 [cm2 sr keV/keV] without losing any part of full azimuthal angle coverage; it obtains full solid angle coverage by using of S/C spin. The performances of the test model have been confirmed by some experiments: particle counting test, UV rejection tests, and withstand voltage tests. TOF unit has also been designed through numerical simulations. The results show that it can discriminate all the major ion species in the earth's magnetosphere, such as H+, He2+, He+, O2+, and O+.