GEOSPACE ENVIRONMENT SIMULATOR AND THE APPLICATION TO THE ANALYSIS OF PLASMA EMISSION FROM ION PROPULSION ENGINE

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ABSTRACT

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In the space development and utilization, it is very important to understand the interactions between spacecraft/structures and space plasma environment. In order to evaluate the spacecraft-plasma interactions quantitatively to contribute to the progress of space utilization and space technology, we aim to develop a proto model of "Geospace Environment Simulator (GES)" by making the most use of the conventional full-particle simulations. GES can be regarded as a numerical chamber in which we can virtually perform space experiments and analyze the temporal and spatial evolution of spacecraft-plasma interactions. The geospace environment simulator will be able to provide fundamental data regarding various engineering aspects such as the electrostatic charging and electromagnetic interference of spacecraft immersed in space plasmas, which will be useful and important information in determining designs and detailed specifications of spacecraft and space systems. The hardware we have been using for the development of GES is the Earth simulator which is regarded as one of the fastest supercomputer system in the world. In the present paper, we will briefly introduce the GES software.

By using GES on the Earth simulator, we started performing large-scale computer experiments with electromagnetic Particle-In-Cell (PIC) model. As one of the simulation models, we adopted a model of heavy ions emission from ion propulsion engine which will be utilized in the future for the orbit transfer of large-scale space structures from LEO to GEO. In the computer experiments, we assume a plasma emitting point in the center of a huge three-dimensional simulation space. The simulation space is composed of several hundreds of vector processor node and all domains are filled with magnetized space plasmas. From the plasma emission point, we emit heavy ions for the propulsion and simultaneously thermal electrons for the charge neutralization. We focus on the dynamics of heavy ions and thermal electrons emitted from the ion engine and the response of the background plasma as well as the field perturbation caused by the plasma emission. In addition to the behavior of the emitted ion beam and the associated field response in ion scale spatial range, we also analyze the plasma environment in the vicinity of spacecraft including its surface charging. In the

model of this situation, we can introduce unstructured spatial grid points which enable us to handle the complex structure of spacecraft in the simulation space. In the computer experiments, we emit the same amount of ion and electron currents from the ion engine to establish the charge neutralization in its vicinity. We focus on the charge neutralization process near the spacecraft surface in terms of dynamics of ion beam and electrons.