Time evolutions of three-dimensional potential structure of ion beam instablilties

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To explore and utilize the geospace environment efficiently, it is very important to understand interactions between spacecrafts and electromagnetic environment around themselves. Recently, influences of spacecrafts on space electromagnetic environment are gradually increasing due to new space technologies such as an ion engine used in various spacecrafts. When the ion engine emit a large quantity of accelerated heavy ions into the space, these heavy ion beams interact with space plasmas around the spacecraft, which can excite various kind of beam instabilities and plasma waves. This kind of beam instabilites and plasma waves become serious noises in observing electromagnetic environment in space by scientific satellites.

In order to investigate time evolutions of ion beam instabilities excited by ion beams emitted from ion engine, as a case study of the influences on space environment by spacecraft, we are performing three-dimensional computer experiments of ion beam instabilities, and demonstrate nonlinear evolutions of ion beam instabilities, in time as well as in space. Simulation study of beam instabilities are difficult because these instabilities are very sensitive to numerical thermal noises in full-particle simulations. We developed, therefore, three-dimensional particle simulation code which is specialized to parallel computing on large-scale super computers. In the present study, we perform three-dimensional particle simulations of the most fundamental beam instabilities excited by a spatially uniform beam at first. Next, we perform simulations of localized beam instabilities excited by a spatially localized ion beam, and investigate on the interaction between ion beam and space electromagnetic environment. Especially, we focus on the spatial characteristics on the perpendicular plane against the ambient magnetic field.

In analyzing time evolutions of three-dimensional spatial structure of potential, electric fields, magnetic fields, electron densities, etc., it is essential how to visualize these three-dimensional spatial structures. We are developing various visualization tools for three-dimensional spatial structures with using AVS. With our visualization tools, we can see spatial structures with stereoscopic vision, in addition can observe their time evolutions in animation. These visualization tools are useful to analyze time evolutions of three-dimensional spatial structures of various phsical parameters.