THREE-DIMENSIONAL ELECTRO-MAGNETIC PARTICLE SIMULATIONS OF THE SOLAR WIND-MAGNETOSPHERE INTERACTION WITH TIME-VARYING IMF USING HPF TRISTAN CODE

D. Cai[(1)], and K. Nishikawa[(2)]

1. ***DongSheng Cai, Inst. Infor. Sci. & Elec., University of Tsukuba, Tsukuba, 305-8573 (Japan) (e-mail: cai@is.tsukuba.ac.jp)***
2. ***Ken-ichi Nishikawa, Department of Physics and Astronomy, Rutgers University, New Jersey, (USA) (e-mail: kenichi@physics.rutgers.edu)***

ABSTRACT

A 3-D electromagnetic particle-in-cell code, TRISTAN code, has been developed as a High Performance Fortran (HPF) program on the Fujitsu Supercomputer VPP5000. The code is used to investigate kinetic plasma processes associated with the solar wind-magnetosphere interaction, especially on the relation between the interplanetary magnetic field and the particle flux in polar region. The range of physical processes involved in the solar wind-magnetosphere interaction is quite overwhelming, many important and intriguing phenomena of which are only partially understood. To include complete physics of particle dynamics, a number of simulations have been performed using hybrid codes (fluid electron, particle ions) and full particle codes [1]. Most particles and energy of the magnetosphere are come from the solar wind. The transport mechanism in the solar wind-magnetosphere system is one of the fundamental, long-term-standing problems of space physics. Magnetic reconnection and associated magnetic convection is generally recognized as an essential transport mechanism, involving in explosive energy releases (magnetospheric substorms and storms) and in formation of magnetic topologies (open magnetosphere). To investigate the interaction between the interplanetary magnetic fields and magnetosphere, involving both macroscopic and microscopic processes, a massively parallel three-dimensional full electromagnetic (EM) particle-in-cell (PIC) code has been developed using recent parallel computer. It allows us to simulate the global solar wind-magnetosphere interaction using a large number of particles in a cell. The code is written in High Performance Fortran (HPF) so that the code can be run on any parallel computers with the HPF compilers. Using the Fujitsu Supercomputer VPP5000/56, we have performed particle simulations with more than 50,000, 000 particles. Some basic kinetic behaviors of space plasma in the magnetosphere have been investigated including global changes with time-varying IMF. The simulations show the formation of the magnetosphere with magnetopause, magnetosheath, magnetotail, plasma sheet, and polar cusps. Due to the reconnection at the dayside magnetopause the convection pattern across the entire polar cap begins to change a few minutes after the arrival of a southward IMF. In contrast, the response of the equatorward motion of the open-closed field-line boundary that depends on the local time is delayed about 20 minutes relative to the onset of the reconnection at the dayside magnetopause. This time delay is considered as the time required to convect the newly merged flux from the dayside magnetopause to the nightside inner magnetosphere. In the simulations, we have also investigated the particles in CUSP regions respond to varying IMF. It is found that many, but not all southward IMF could cause the particle disposition in CUSP regions and an intense southward IMF could push the particles in CUSP regions to magnetotail-ward directly, which may be related to substorm or magnetic reconnection. Our code is a successor to the TRISTAN code [1], which utilizes charge-conserving formulas and radiating boundary conditions. It is written in HPF so that that the code can be run on any parallel computers with the HPF compilers [2,3].

REFERENCES

[1] Buneman, O., Neubert, T. and Nishikawa, K.-I., Solar wind-magnetosphere interaction as simulated by a 3-D, EM particles code, *IEEE Trans. Plasma Sci.*, 20, 810,1992.

[2] Li, Y. T. and Cai D. S., Optimizing pgHPF CSHIFT communications using PentiumPro PC cluster for 3D particle simulation, *ParCo 99*, 1999.

[3] Cai., D. S. and Li., Y. T., Massively parallel three-dimensional full electomagnetic (EM) particle-in-cell (PIC) simulations of global reconnections and the global changes of magnetic field topology, *Proc. 1st S-RAMP Conference*, Sapporo, Japan, October 2-6, 2000.