Numerical modeling of space plasma processes

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Abstract

This project investigates basic processes in space plasmas, by using supercomputer simulations. In particular, we study "magnetic reconnection" in space, an abrupt change in magnetic topology. In order to support research activities by ourselves and by other groups, we develop massively-parallel simulation codes. They are publicly available on the Internet.

Ref. URL: http://th.nao.ac.jp/MEMBER/zenitani/openmhd-e.html

Reasons and benefits of using JAXA Supercomputer System

Space plasma processes are basically described by magnetohydrodynamics (MHD) equations, which are notoriously complex. Supercomputer simulation is necessary to predict the nonlinear evolution of the system.

Achievements of the Year

We have studied basic properties of plasmoid-dominated turbulent reconnection in solar coronal conditions. By carrying out a series of magnetohydrodynamic (MHD) simulations, we have found that the flux tranfer rate becomes faster than expected [4]. We have also developped a high-accuracy numerical scheme for particle-in-cell (PIC) simulations to study kinetic plasma phenomena [1].

Publications

- Peer-reviewed papers

[1] S. Zenitani & T. N. Kato, Multiple Boris integrators for particle-in-cell simulation, Comput. Phys. Commun., 247, 106954 (2020)

[2] W.-L. Teh & S. Zenitani, Thermodynamic Properties of Mirror Structures in the Magnetosheath: MMS Observations and Double-Polytropic MHD Simulations, Astrophys. J., 885, 22 (2019)

[3] W.-L. Teh & S. Zenitani, Thermodynamics of Dipolarization Fronts of Magnetic Reconnection in Anisotropic

Plasma: MMS Observations and Resistive Double-polytropic MHD Simulations, Astrophys. J., 890, 114 (2020)

- Other

[4] S. Zenitani & T. Miyoshi, Plasmoid-dominated turbulent reconnection in a low beta plasma, submitted to Astrophys. J. Letters

Usage of JSS2

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	40 - 2000
Elapsed Time per Case	36 Hour(s)

Resources Used

Fraction of Usage in Total Resources[*1](%): 0.00

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
SORA-MA	3,609.70	0.00
SORA-PP	0.00	0.00
SORA-LM	0.00	0.00
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2(%)
/home	67.29	0.06
/data	1,228.12	0.02
/ltmp	3,146.70	0.27

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2(%)
J-SPACE	0.00	0.00

*1: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

*2: Fraction of Usage：Percentage of usage relative to each resource used in one year.