Magnetohydrodynamic simulations 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.

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

Reasons for using of JSS2

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 by carrying out a series of large-scale magnetohydrodynamic (MHD) simulations. We found that the average energy consumption rate of the turbulent state is described by a simple scaling theory. Related to this topic, we evaluated the influence of the numerical resolution in transition from quiet laminar reconnection to turbulent reconnection in our collaboration paper [1].

We have been improving our MHD code. For example, the 2018 version of our code employs MPI nonblocking communication, and it runs faster than the previous versions as shown in Fig. 1. As a future option, we have also implemented a new communication code, based on MPI-3 shared-memory communication.

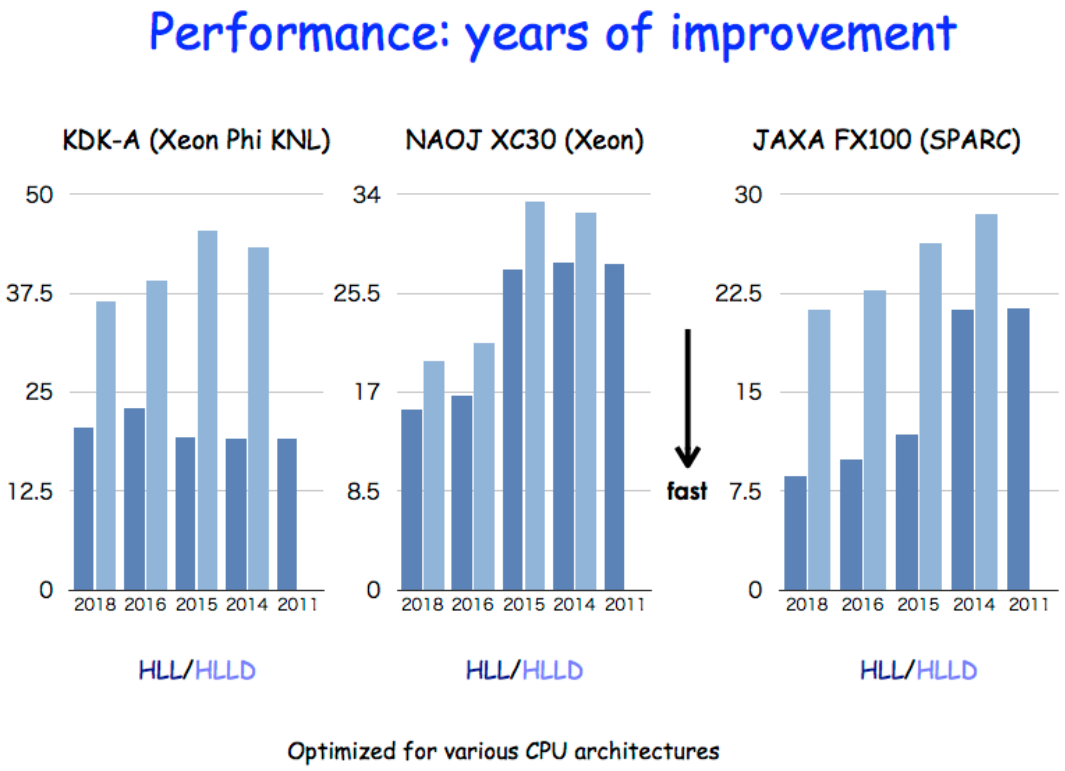

Fig.1 Benchmark results of our MHD code on several systems

Publications

- Peer-reviewed papers

1) T. Shimizu, K. Kondoh, & S. Zenitani, "Numerical MHD study for plasmoid instability in uniform resistivity", Physics of Plasmas, 24, 112117 (2017)

Usage of JSS2

Computational Information

Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	40 - 2000
Elapsed Time per Case	36.00 hours

Resources Used

Fraction of Usage in Total Resources*1 (%): 0.04

Details

Computing Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage*2 (%)
SORA-MA	309,513.20	0.04
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	109.67	0.08
/data	2,096.18	0.04
/ltmp	3,320.31	0.25

Archiver Resources		
Archiver System 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