Exploration of burning plasma confinement physics using the supercomputer Fugaku

T.-H. Watanabe[1], Y. Idomura[2], Y. Todo[3], and M. Honda[4]

[1] *Nagoya University, Nagoya, Japan*

[2] *Japan Atomic Energy Agency, Kashiwa, Japan*

[3] *National Institute for Fusion Science, Toki, Japan*

[4] *Kyoto University, Kyoto, Japan*

Realization of the burning plasma state in controlled fusion is expected in the ITER project. In advance to the experiments, it is desired to find deeper understandings on key physics issues in the burning plasma confinement by means of numerical simulations based on the first principles in plasma physics. During the initial start-up phase of the the supercomputer Fugaku, we have launched a simulation project to explore physics of burning plasma confinement [1], that is, the turbulent transport of particles, momentum, energy, impurity ions and hydrogen isotopes, and confinement of energetic particles, in collaboration with data science approaches. In prior to the project, we have upgraded and optimized three major fusion plasma simulation codes, GKV, GT5D and MEGA, which solve the kinetic plasma dynamics on multi-dimensional phase space, achieving the high computational performance on Fugaku. Under the project, the flux tube gyrokinetic code, GKV, is applied to simulations of the multi-scale turbulence in multiple ion species plasma and the turbulent transport of heavy impurity ions. The global full-*f* gyrokinetic code, GT5D, is employed to explore non-local turbulent transport and intrinsic plasma rotation. The kinetic-MHD hybrid code, MEGA, is used for studying confinement of energetic ions, and has also been extended to introduce kinetic dynamics of bulk ions. In the project, data science approaches are also promoted to improve transport modeling and efficiency of the simulation research. The cutting-edge simulation results obtained by means of Fugaku will also be discussed in the conference.

References

[1] https://www.p.phys.nagoya-u.ac.jp/bpp/