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Performance Measurement of Magnetohydrodynamic Simulation Code for Planetary Magnetosphere on FX10

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For investigating the global structures of plasma, such as the planetary magnetospheres, the Magnetohydrodynamic (MHD) equations are often used, in which full kinetics of plasma are neglected by taking the moments of the Vlasov equations. The MHD equations are highly nonlinear and are very complex to solve by hand calculations. Thus computer simulations play essential roles in studies of global magnetosphere.

The numerical MHD code for the magnetosphere has been optimized for vector-type supercomputers for a long time because the MHD code is a kind of fluid code and most of supercomputers with vector processors have high performance to solve the fluid codes in 1990's. These codes often have achieved a very high computational efficiency (the ratio of the effective performance to the theoretical performance). However, recently almost 100% of the "Top 500" supercomputer systems in the world adopt the massively parallel scalar type processors and more than 85% of systems consist of the x86 processor architecture. The other scalar type computers are POWER and SPARC architectures. In general, the computing efficiency of user applications on a massively parallel scalar-type computer tends to be low (˜5%), although the computing efficiency of LINPACK sometimes exceeds over 80%. Optimizing performance in the various scalar type computers, our MHD code achieved the 14˜30%, however we have not obtain good efficiency as same as the efficiency with the vector type computer and have not run our code on over the ten thousand cores.

In this year the several computer systems consisted of Fujitsu PRIMEHPC FX10 which is the massively parallel scalar type computer with SPARC architecture have been established. In the University of Tokyo, there is the largest system of FX10 which has 4800 nodes (76,800 cores). In this study we will show the performance measurements of MHD code for the planetary magnetosphere with all nodes on the University of Tokyo. For parallelization of the MHD code, we use four different methods, i.e., regular one-dimensional, two-dimensional, three-dimensional domain decomposition methods and a cache-hit type of three-dimensional domain decomposition method. As the results, we found that the cache-hit type of three-dimensional decomposition of the MHD model is suitable for FX10 system and achieved computing performance of 230TFlops and efficiency of almost 20% for MHD code.