Development of N-body Simulation Code for Planetary System Formation: GPLUM

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In general, the planetary system is thought to be formed from protoplanetary disks surrounding the central star. In particular, it is accepted that terrestrial planets and the cores of gas giant planets are formed by accretion of km size objects (planetesimals) in the protoplanetary disk. The accretion process of the planets has been mainly discussed using the gravitational multi-body simulations (N-body simulations) of planetesimal systems.

We have developed a new N-body simulation code with particle-particle particle-tree (P^3T) scheme for planetary system formation, GPLUM. The code GPLUM uses a fourth-order Hermite scheme to calculate gravitational interactions between particles within a cut-off radius and a Barnes-Hut tree scheme for gravitational interactions from particles beyond. The conventional simulation codes with P^3T scheme has the bottleneck that the calculation speed decreases when the mass ratio among the particles becomes large. We have solved it by implementing an algorithm which determines the cut-off radius based on mass and velocity dispersion of particles individually for each particle. The performance of GPLUM is significantly improved for the simulations of particle systems with mass distribution. We have tested the calculation performance of GPLUM for large-scale calculation using the supercomputer Fugaku.

By improving the performance of the N-body simulation code, we made it possible to carry out numerous global simulation with various parameters. By using GPLUM, we will perform N-body simulations with wide range and high resolution and investigate various parameters by perform parameter studies with N-body simulations.
We will report results of the performance evaluation of GPLUM in Fugaku and the large-scale sumulations of planetary accumulation.

Keywords: planet formation, N-body simulation

