Large Scale N-body simulation of Planet Formation: Effect of Fragmentation of Planetesimals

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Abstract

When planetesimals collide with each other, fragments should be formed. Since if such fragments are included in the N-body simulations, the number of N increases and the simulation becomes heavy. That is why such large scale simulations was not carried out in the past. We included the fragmentation of the planetesimals and the protoplanets and carried out more realistic N-body simulations then ever.

Reasons for using JSS2

So far, number of particles we could calculate for N-body simulation was about 30 thousand even if special purpose accelerater called GRAPE was used. However, in order to express the inward and outward movement of the bodies, wider disk and larger number of particles (about 100 thousand particles) become necessary. We need to parallelize the code and use super computer.

Achievements of the Year

As for the initial condition, we used that of the second stage simulation in Kominami et al. (2016). We followed Kominami et al. (2005) for including the effect of gas drag and type-I migration. In order to see the effect of increase of number of bodies (N), we used a simplified fragmentation model. The gas drag damps the random velocity of the smaller bodies more easily. Such small bodies (fragments and small planetesimals) help the protoplanet move outward by planetesimal driven migration. When only perfect accretion was assumed, the planetesimals residing right behind (outer side of the protoplanet) grows. However, when fragmentation is considered, almost always small bodies reside right outside the protoplanet. One of the main criteria for the planetesimal driven migration to take place is the mass ratio of the protoplanet to the planetesimal has to be more than about 100. While the assumption of perfect accretion let the planetesimals grow to the size that the criteria breaks down, the fragmentation helps the outer migration.

Publications

N/A

Usage of JSS2

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	32 - 168
Elapsed Time per Case	60 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	11,368.36	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	4.77	0.00
/data	47.68	0.00
/ltmp	976.56	0.08

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.