High-resolution N-body Simulations for Planet Formation: To 100 Million Particles, and Beyond

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In a collisional system, close encounters play an important role in dynamical evolution. Gravitational interactions between particles undergoing a close encounter are big bottlenecks in N-body simulations because of high computational costs. In fact, a direct N-body simulation in the context of planet formation faces a wall of ten thousand particles. Toward high-resolution N-body simulations with 100 million particles and beyond, we have developed three tips to overcome this sort of big wall, implementing them into our N-body code for planet formation: (i) a tree-based hybrid N-body scheme which reduces numerical integrations of gravitational interactions among particles, PPPT method (Oshino et al. 2011), (ii) GPU clusters which allow us to handle a large number of particles, (iii) parallelization and optimization for accelerating numerical integrations, specifically, a multi-purpose platform for a parallelized particle-particle simulation, the so-called “Framework for Developing Particle Simulator” (FDPS: Iwasawa et al. 2015). In this talk, we introduce what our brand-new N-body code is like and its performance and capability. We also show our preliminary results of N-body simulations of terrestrial planet formation, using ~ 0.1-1 million planetesimals.

Keywords: Planet formation, N-body simulation, GPU

