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Dear Gordon Bell Prize committee members,

I have been closely collaborating with the authors of this paper on various aspects of simulations of rings and planetary formation process. So my opinion might be a bit biased. So far, for planetary formation process, "global" simulations have been done. Here, "global" actually means simulations of relatively narrow radial range (for example, 0.9 to 1.1 AU), with relatively small number of particles (less than 10^5). For ring simulations, local models (small in both radial and tangential direction) have been used typically with $10^{5\text{-}6}$ particles.

In both cases, truly global simulations with much larger number of particles are clearly necessary, but nobody has actually performed such large simulations. The main reason why such simulations have not performed is basically the lack of the necessary software. In the case of cosmological *N*-body simulations, very large number of particles (more than 10^{12} particles) have been used. Thus, in principle it has been possible to use similarly large number of particles for planetary rings or planetary formation process. However, one could not simply use cosmological simulation codes for planetary simulations. There are a number of small but essential differences which make the adaptation rather difficult.

The authors have been developing the FDPS framework, which makes it possible to develop the highly efficient parallel *N*-body simulation code for many different problems. This framework was used already by Michikoshi and Kokubo to perform a global simulation of rings with 300M particles. This is the largest ring simulation performed so far, but still not large enough to model real planetary rings. They modeled rings around an asteroid. Since the rings are physically small, the necessary number of ring particles was relatively small.

In the present paper, the authors demonstrated that much larger simulation with 10^{12} particles for a ring is possible with their framework and fast machines. They have implemented a number of modifications, some of which are specialized to the ring geometry, and achieve very high efficiency. Now we can really model rings of large planets, like Saturn and Uranus, with ring particles of real physical size. I'm eager to look at their results.

Yours sincerely,

H. Daisaka

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