有無自己重力の微惑星円盤による惑星と小天体の軌道進化

Patryk Sofia Lykawka (近畿大学)*

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I have performed a vast number of computer simulations continuing from those that started during the previous year (H21). In addition, I also performed a new series of simulations during the H22 year, thus finishing all simulations of the entire project. The research topics covered in this project represent an unprecedented comprehensive work done on the dynamics of the asteroid belt, Kuiper belt, and planets during the early solar system using massive planetesimal disks with and without self-gravity. Therefore, the various results from these calculations will render a number of publications in international refereed journals and conferences in the next few years. More details on the importance, current status and preliminary results are shown below. Because most of the work done in H22 was a continuation of that in H21, some contents of this report are similar to that submitted last year.

Dynamical evolution of planets and small bodies in massive planetesimal disks with and without self-gravity

I aim to investigate the dynamical outcomes of the four giant planets during the early solar system after they leave their initial mutual orbital resonant configurations. Another important goal is to understand what the typical outcomes are for these systems, and what these results can tell us about the early evolution of the solar system and extrasolar systems. This also includes investigating the influence of massive planetesimal disks on the orbital evolution of giant planets and small body reservoirs, such as the asteroid and Kuiper belts.

I investigated planetary systems including massive disks with and without self-gravity and the four giant planets. Worth noting, the inclusion of self-gravity in some of these simulations is a very unique feature of this project. In some cases, the terrestrial planets and both the asteroid and Kuiper belts were taken into account in the simulations. Therefore, all the simulations provide the most comprehensive ever picture of the early evolution of the solar system. To provide statistically meaningful results and recalling the stochastic behaviour of such systems, I decided to perform 5-10 simulations of each specific initial configuration for all systems. The vast number of initial conditions and the very computer-consuming simulations of disks with self-gravity allowed me to finish all the runs by the end of year H22!

I performed tens of simulations of systems using massive planetesimal disks with self-gravity, and a few hundreds of simulations for systems that included similar disks, but without self-gravity. These simulations covered four main initial configurations for the giant planets and two typical disk total masses (low and high disk mass). The disks were composed of 10000 and 2000-5000 bodies for the cases of disks without and with self-gravity, respectively. In all simulations the systems evolved over 20-100 Myr. After that, I chose a significant number of representative simulations and evolved them over 4 Gyr, roughly the age of the solar system.

The complete set of simulations was completed recently. Thus, unfortunately I have not started analyzing the output data so that I am unable to show the preliminary results at the moment. However, considering the volume of data obtained from the comprehensive simulations described in this project, I anticipate that several papers will be a natural outcome over the next 1-2 years.