The Effect of Initial Mass of Planetesimals to The Planet Formation Process

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We have developed a new direct-tree hybrid scheme, which allows us to handle very large number of planetesimals, while guaranteeing high accuracy. We report the result of the first large-N simulation of planetary formation process.

In the present planet formation theory, it is assumed that planetesimals evolve to protoplanets and cores of gas giant planets through mutual collisions. According to the gravitational instability theory, the mass of the initial planetesimal is the total mass of dust in the wavelength of gravitational instability that exist on a protoplanetary disk becomes. Using the property of the standard solar system disk, the mass of the initial planetesimal formed with gravitational instability is about 10^{18}g by the distance of 1AU from the Sun. In the previous N-body simulations, the initial condition of planetesimal mass about 10^{23}g is used because of the limitation in the computer resources. These simulations show that planetesimals accrete light planetesimals selectively and planetesimals in the mass range of $10^{\mathbf{21-24g}}$ follow the mass distribution about $m^{-2.5}$. Because gas drag force is effective for lighter planetesimals, it is possible that the mass distribution and planet formation process become different when we take into account less massive planetesimals. Therefore it is important to study behavior of light mass planetesimals in the planetary disk.

These influences are not examined well by using N-body simulation, because the calculation cost increases as the second power of the number of particles. Moreover, in planet formation simulations, since the formation time is far longer than the orbital timescale of planetesimals, very long calculation is necessary. Then we use the new developed hybrid N-body simulation code for the planet formation process and examine the influence of light mass planetesimals.

References

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