On Runway Growth of Planetesimals in Binary Systems

Makiko Nagasawa[1]; Eiichiro Kokubo[1]

[1] NAO

Known extrasolar planets orbit not only around single stars but also around stars in binary systems (e. g., Cochran et al. 1997). The extrasolar planets around binaries are believed to have accreted from the circumstellar disks in a similar way around the single stars. However, since the motion of the planetesimals around a star of binary system is strongly perturbed by the companion star, their motions would differ from the ones around the single star. After the formation of the protoplanets, several terrestrial planets also can be formed in this Alpha Centauri system (Quintana et al. 2002). However, although it is suggested the planetesimal accretion is possible in the disk under the influence of the binary companion because of the orbital phasing forced by gas drag (Marzari & Scholl 2000), the actual simulation of the planetesimal accretion in the binary system including mutual gravity has not been addressed previously.

We calculate the growth of the self-gravitating planetesimals around the Alpha Centauri by N-body simulations using GRAPE-6. We study how the accretion process changes from the ones around single stars. We put the disk consists of several thousand small planetesimals with constant masses in a ring region around Alpha Centauri at 1 AU. In close binary systems, the protoplanets cannot grow without the phase forcing effect because the encounter velocities in the planetesimals are too high. We find that the planetesimals show the corrective behavior due to the mutual gravity and secular perturbation caused by the companion star. Other than the corrective behavior, the protoplanets around the binary system grow in a way similar to how they grow around the single stars.

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