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Binary formation in Planetesimal Disks

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As of April 2010, 48 TNO (trans-Neptunian Object) binaries have been found. This is about 6% of known TNOs. However, in previous theoretical studies of planetary formation in the TNO region, the effect of binary formation has been neglected. TNO binaries can be formed through a variety of mechanisms, such as three-body process, dynamical friction on two massive bodies, inelastic collisions between two bodies etc. Most of these mechanisms become more effective as the distance from the Sun increases. In this paper, we studied three-body process using direct N-body simulations.
We found that, Chaos-Assisted-Capture (CAC) is the dominant channel of binary formation.
We systematically changed the distance from the Sun, the number density of planetesimals, and the radius of the planetesimals and studied the effect of the binaries on the collision rate of planetesimals. In the TNO region, binaries are involved in 1/3 - 1/2 of collisions, and the collision rate increases by a factor of a few compared to the theoretical estimate for the direct two-body collisions. Thus, it is possible that the binaries significantly enhance the collision rate
and reduce the growth timescale. In the terrestrial planet region, binaries are less important, because the ratio between the Hill radius and physical size of the planetesimals is relatively small. Although the time scale of our simulations is short, they clearly demonstrated that the accretion process in the TNO region is quite different from that in the terrestrial planet region.
We also performed N-body simulations of planetesimal disks from 30 AU - 30.2 AU with planetesimal mass distributions.
We show the formation of
binary in trans-Neptunian region is not rare quantitavely.
Disks with high surface density and low random velocity are likely to form binaries easily. There is a tendancy of formation of binaries with similar mass components.
Binary formation is almost proportional to the surface density of the planetesimal disk, and almost inversely proportional to the initial random velocity.
Inclination and eccentricity distribution is consistent with the observational result.

Keywords: planetesimal binary, TNO, accretion