Orbital evolution of solid bodies in circumplanetary gas disks

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In the late stage of the formation of giant planets, sufficiently massive proto-giant planets capture gas and solids from the protoplanetary disk and form circumplanetary disks. Regular satellites of the giant planets such as the Galilean satellites of Jupiter are orbiting in the prograde direction in approximately circular and co-planer orbits, thus they are thought to be formed in the circumplanetary disks. Orbital decay of solid bodies is caused by different mechanisms depending on their sizes. When the solid bodies are small, aerodynamic gas drag is dominant (Adachi et al. 1976). Sufficiently small bodies are coupled to the gas and would be supplied to the circumplanetary disks with the inflowing gas (e.g., Canup & Ward 2002). Planetesimals that are large enough to become decoupled from the motion of the gas can be captured by gas drag from the circumplanetary gas disk (Fujita et al. 2013). It has been recently shown that the efficiency of capture of planetesimals from their heliocentric orbits by gas drag from the circumplanetary disk is the highest for planetesimals with radii of 10-100m (Tanigawa et al. 2014). While the so-called type-I migration is important in the late stage of satellite formation, orbital evolution by aerodynamic gas drag governs the orbital evolution of small solid bodies, and dynamical evolution of such small bodies in the circumplanetary gas disks is important for the growth of protosatellites. In the present work, we examine orbital evolution of planetesimals in circumplanetary gas disks, and the probability of capture of such small bodies by a growing protosatellite (Shimizu & Ohtsuki, in preparation).

We numerically evaluate the probability of collision of migrating planetesimals with the protosatellite, and its dependence on the size of planetesimals. We find that the collision probability has a peak at a certain size. This is because the time scale of the orbital decay varies depending on the size of planetesimals. We also examined cases of various masses and semi-major axes of the protosatellite, and obtained similar results. Finally, we will also discuss effects of gravitational interaction between planetesimals (Kawamura, Ohtsuki, Suetsugu, this meeting).

Keywords: Satellite formation

