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Accretion Flow onto Circum-Planetary Disks and Satellite Formation

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Most of major natural satellites around the giant planets in our solar system are classified into " regular satellites", whose orbits are nearly in circular orbits and in the equatorial plane of the parent bodies. The satellites are thus thought to form in circum-planetary disks. However, the origin and the properties of circum-planetary disks are not well understood. Recently, some hydrodynamic simulations showed that gas flow accreting toward the planet forms disk-like structure in the course of gas capturing process to be gas giant planets, thus circum-planetary disks are inevitably formed as by-products of the formation of gas-giant planets.
In order to form satellites, however, solid material needs to be supplied to the circum-planetary disks. The way of supplying solid material can be divided into two. For small objects, they move with gas because of strong gas drag. For large objects, they are basically decoupled with gas motion and affected weakly by gas-drag. In the period of giant planet formation, collision between relatively large objects are frequently occurred and large fraction of solid may be in the form of small dust particles, which couple well with gas motion.
In this study, we conduct high-resolution gas accretion flow from proto-planetary disks to gas giant planets in order to understand structure of circum-planetary disks and resultant dust accretion in the context of satellite formation. We analyze the accretion flow in detail and show that (1) gas near the mid plane in proto-planetary disks are difficult for accretion to the planets, and as a result, sedimentary dust are difficult to be supplied to circum-planetary disks, (2) gas that is going to accrete to the planets is fallen directly within less than 0.05 Hill radius from the planets, meaning that disk-like structure outside of the radius cannot accrete to the planet and dust in the region would not be material to form satellites.

Keywords: satellites, giant planets, disks, hydrodynamic simulation