Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PPS01-11 Room:201B Time:May 21 17:00-17:15

Formation Processes of Regular Satellites around Giant Planets

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Satellite systems around the giant planets in our solar system are commonly seen. They are thought to have formed in circumplanetary disks, which are believed to have existed around giant planets during their gas capturing growing stage.

In earlier works, the formation process of satellite systems has been considered based on a minimum mass subnebula (MMSN) model, in which satellites form from a disk that contains sufficient solid mass with solar composition for reproducing the current satellite systems (e.g., Lunine and Stevenson 1982), as an analog of the minimum mass solar nebula model (Hayashi 1981). However, it was suggested that the MMSN model has difficulty in reproducing current satellite systems around Jupiter and Saturn (Canup and Ward 2002). One of the severe problems is that the model leads to much higher temperature than that of H2O ice sublimation at the current regular satellite region, which means that ice, which is the main component of the satellites, cannot be used as building material of the satellites.

In order to overcome the difficulties of the MMSN-type models which assume a closed and static disk, alternative models have been developed. Canup and Ward (2002) proposed a model in which an accretion disk with a continuous supply of gas and solid is considered as a proto-satellite disk. This model reproduces ratio of total satellite mass to the parent planets' mass for Jupiter, Saturn, and Uranus.

Recently, Crida and Charnoz (2012) showed that if a massive ring around a giant planet exists, it spreads outward by radial diffusion, which could produce regular satellites. This model can reproduce satellite masses and orbital radius simultaneously for Saturn, Uranus, and Neptune.

In this talk, satellite formation processes mainly of the two major hypotheses will be reviewed.

Keywords: satellite, moon, Jupiter, giant planets