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Effect of wave propagation for a planet-induced gap formation in protoplanetary disks

KANAGAWA, Kazuhiro[1*] ; MUTO, Takayuki[2] ; TANAKA, Hidekazu[1] ; TANIGAWA, Takayuki[3] ; TAKEUCHI, Taku[4]

[1]ILTS, Hokkaido University, [2]Division of Liberal Arts, Kogakuin University, [3]School of Medicine, University of Occupational and Environmental Health, [4]Department of Earth and Planetary Sciences, Tokyo Institute of Technology

In a protoplanetary disc, a large planet is able to create the so-called disc gap, which is a low gas density region along with the planetary orbit, due to the gravitational interaction between the disc and the planet. The gap formation significantly affects the orbital evolution of planets such as the transition from type I migration to type II migration. It also prevents disc gas from accreting onto the planet and slows down the planetary growth. In addition, the gap formation induced by a giant planet possibly explains the formation of the so-called pre-transition disc with a ring gap. Hence, it is important to determine the relation between the planet mass and the gap depth and width.

According to our analysis with the one-dimensional model, the propagation and damping of the density wave excited by the planet is closely related to the gap depths and widths (Kanagawa et al 2015). Therefore, we computed the gap structure around the planet using FARGO, which is an open source code for hydrodynamic simulation. Results of the simulation show that in the case with the large planet (such as Jupiter), low-mode waves (in particular m=2 mode) become stronger than high-mode waves. Because the low-mode waves would be difficult to be damped by shock dispersion, these waves can propagate farther from the planet than high-mode waves.

In this talk, I will illustrate the results and discuss the wave propagation and gap formation for large planets.

Keywords: protoplanetary disk, disk-planet interaction, disk evolution