Model of a gap formed by a planet with fast inward migration

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A planet is formed within a protoplanetary disk. Recent observations have revealed substructures such as gaps and rings, which may indicate forming planets within the disk. Due to disk--planet interaction, the planet migrates within the disk, which can affect a shape of the planet-induced gap. However, it is still an open question when and where the planet forms and how it evolves within the protoplanetary disk. In this paper, we investigate effects of fast inward migration of the planet on the gap shape, by carrying out hydrodynamic simulations. We found that when the migration timescale is shorter than the timescale of the gap-opening, the orbital radius is shifted inward as compared to the radial location of the gap. We also found a scaling relation between the radial shift of the locations of the planet and the gap as a function of the ratio of the timescale of the migration and gap-opening. Our scaling relation also enables us to constrain the gas surface density and the viscosity when the gap and the planet are observed. Moreover, we also found the scaling relation between the location of the secondary gap and the aspect ratio. By combining the radial shift and the secondary gap, we may constrain the physical condition of the planet formation and how the planet evolves in the protoplanetary disk, from the observational morphology. In this talk, I present the results of our hydrodynamic simulations and discuss how we can constrain the planet formation from the gap structure.

Keywords: Planet formation, Protoplanetary disk, Disk-Planet interaction

