Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PPS21-20 Room:A02 Time:May 24 15:45-16:00

On Shortwave Emission from Accreting Gas-Giant Planets

AOYAMA, Yuhiko[1*] ; TANIGAWA, Takayuki[2] ; IKOMA, Masahiro[1]

[1]Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, [2]School of Medicine, University of Occupational and Environmental Health

Planets have been thought to form in circumstellar gaseous disks (or protoplanetary disks), which are remnants of star formation. Some young stars surrounded by protoplanetary disks are already detected. Also, Atacama Large Millimeter/submillimeter Array (ALMA) has recently detected gap-like structure in a protoplanetary disk, which may be formed as a consequence of gravitational interaction between the disk and unseen planets. A challenging issue is how to find growing planets in protoplanetary disks directly. In this study, we investigate whether detectable emission occurs from accreting gas-giant planets.

In the core accretion models for formation of gas giant planets, a solid core with the critical core mass starts to get disk gas in a runaway manner. In this phase (called the runaway gas accretion phase), gas flows into the planet from the protoplanetary disk at a high accretion rate. Since the accretion of disk gas occurs much faster than loss of the angular momentum of the disk gas, a circumplanetary disk, which extends to the planet's Hill radius, is formed in the mid-plane of protoplanetary disks. Recent three-dimensional hydrodynamic simulations by Tanigawa et al. (2012) revealed that the disk gas flows into the circumplanetary disk not horizontally through the Lagrange points from the protoplanetary disk, but vertically from high altitudes. According to those simulations, the disk gas falls onto the circumplanetary disk with a speed comparable to the free fall speed, and the local gas temperature reaches up to tens of thousands of kelvin because of shock heating near the planet.

Thus, the presence of an accreting gas giant planet in a protoplanetary disk may be found by observing the radiative emission from such hot gas in the circumplanetary disk, which we aim to confirm in this study. Based on Tanigawa et al. (2012), we estimate the temperature of the gas heated by the accretion shock and simulate the thermal emission spectrum. In particular, we evaluate the detectability of the intensity of line emission from hydrogen. We have found, for example, that the Lyman-alpha luminosity from the circumplanetary disk is on the order of 1021 [W] in the case of an accreting gas-giant planet with mass of 130 Earth masses orbiting 5.2 AU in the minimum-mass solar nebula. The value of the Lyman-alpha luminosity is comparable to that from the present Sun. Since this luminosity is proportional to the density of disk gas, the emission continues until the dissipation of the disk gas. Considering the absorption by the interstellar medium and the protoplanetary disk gas, we discuss the detectability of forming gas giant planets for future space telescopes.

Keywords: Planet Formation, Gas-Giant Planet, Exoplanet, Direct Ditection