Equilibrium chemical structure of extrasolar gas giant planets with various elemental abundance and temperature profiles

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It is thought that difference in snowlines of oxygen- and carbon-bearing molecules, such as H_2O, CO, HCN, CO_2, will result in systematic variations in the C/O ratio both in the gas and ice. In addition, the C/O ratio of atomosphere of some exoplanets (e.g., Hot Jupiter) were measured by recent studies (e.g, Madhusudhan et al. 2011). Therefore, the planet forming regions could be confined through comparing the radial distributions of C/O ratio in disks and those of planetary atmospheres (e.g., Oberg et al. 2011, Eistrup et al. 2016).

In previous studies, We have calculated the chemical composition and the molecular line profiles in various protoplanetary disks, and have identified candidate molecular lines ranging from infrared to sub-millimeter wavelengths to locate the position of snowlines and C/O ratio distributions through future spectroscopic observations (e.g., Notsu et al. 2016, ApJ, 827, 113; 2017, ApJ, 836, 118).

In this study, first we calculated the physical structure of irradiated extrasolar gas giant planets using the analytic radiative equilibrium model in Guillot et al. (2010, A&A, 520, A27). Then, we calculated the chemical structure on equilibrium state of the gas giant planets. In these chemical calculations, we adopted various values of the distance from the central star, and elemental abundance (e.g., C, O, N), in order to investigate the relations between chemical structure of planetary atmospheres and their formation conditions in protoplanetary disks.

We found that as the values of temperatures in planetary atmosphere become smaller, the abundance of CH_4 become higher. In addition, as the values of C/O ratio become larger than the solar value, the abundance of CH_4 and HCN become higher in the lower atmospheres. In our talk, we will introduce the present calculational results, and will briefly comment the relations between the calculational results and recent observations.

Keywords: Extrasolar planet, Gas planetary atmosphere, Chemical equilibrium, C/O ratio, Snowline, Protoplanetary Disk